CHAPTER 4

PLOTTING STANDARDS

INTRODUCTION

In the past, Navy and Marine Corps weather observers spent a lot of time plotting observations on charts. With the introduction of computer processing and widespread use of computer printers and plotters, manual plotting has just about become obsolete. Many of the charts you will see are completed analyses received from the Tactical Environmental Support System (TESS), and other computer systems. TESS receives raw data, data fields, and completed analyses and prognoses via the Navy Oceanographic Data Distribution Expansion System (NODDES). However, there are still a few tasks the observer must do to prepare charts for the analyst/forecaster or for a briefing. In this chapter, we discuss the types of charts and chart projections routinely used in meteorology. Then, we discuss some specific types ofproducts used by analysts and forecasters, and the tasks routinely done by to prepare these charts for the forecaster. As we discuss each type of product, we explain the standard data plotting model or method used to display observed data.

CHARTS

LEARNING OBJECTIVES: Describe the two primary coordinate systems used to locate points on the surface of the earth. Identify the terms used to define various regions of the globe. Identify the various chart projections frequently used for meteorological and oceanographic applications. Discuss how station identifiers are used to locate weather stations and airfields.

A chart is a printed reproduction of a portion of the earth's surface, which may show water and land areas. Charts use a coordinate system to locate positions on the chart. The lines of the coordinate system and the shapes and sizes of land masses vary in appearance, depending on the projection and scale of the chart used.

COORDINATE SYSTEMS

Two coordinate systems are used by the military. At sea, naval and merchant vessels use the geographical coordinate system. Within the North Atlantic Treaty Organization (NATO) and the U.S. military, ground forces use the military grid system. Joint operations between naval and ground forces require that you be familiar with both systems of coordinates.

Geographical Coordinates

The geographical coordinate system uses a network of *parallels* (of latitude) and *meridians* (of longitude), which aid in locating the various features shown. Since earth is generally a sphere (actually it bulges slightly near the equator and is slightly flattened near the poles), the most accurate depiction of earth is a globe—a ball-shaped chart of earth. Globes are very difficult to print on flat paper or to accurately depict in a book, so they are seldom used in meteorology or oceanography. Figure 4-1 is a representation of how parallels and meridians are arranged on a globe. Notice that the meridians are farthest apart at the equator and merge at the poles, and that the parallels circle the earth parallel to the equator.

Meridians are measured in degrees of arc, with the prime meridian (0° longitude) established as a line extending north and south through the location of the Royal Greenwich Observatory in Sussex, England. Meridian degrees are referenced as east or west of the

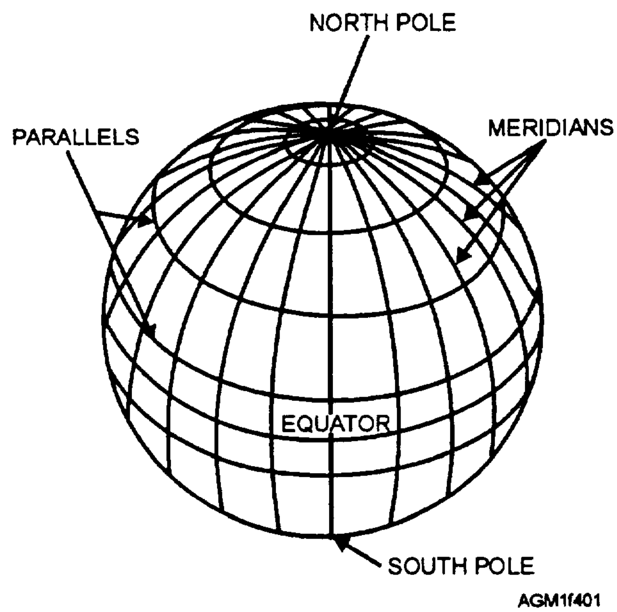


Figure 4-1.—Parallels and meridians on a globe.

prime meridian, and may be drawn on a chart at any convenient interval, such as every 5, 10, 15, or 30 degrees. The opposite of the prime meridian, either 180°E or 180°W longitude, is the international date line.

Parallels are also measured in degrees of arc, but referenced as either north or south of the equator, which is 0° latitude. The highest latitude measurements are 90° north (the North Pole), and 90° south (the South Pole). Parallels are normally drawn on charts every 5, 10, or 15 degrees.

With the system of parallels and meridians, any point on the earth's surface can be accurately located. Each degree (°) may be subdivided into 60 minutes ('), and each minute into 60 seconds ("). In standard use, a location is referenced by latitude, and then longitude, such as 43°21'13"N 073°54'03"W. A nautical mile is defined as 1 minute of arc on a great circle chart. The frequently used approximation that 1° of latitude (on any chart) is 60 nautical miles was derived from this definition. This relationship does not hold true for degrees of longitude, because the meridian lines converge toward the poles.

Locations used to plot positions on meteorological charts need only be accurate to within a few nautical miles. Most meteorological positions are converted to degrees and tenths of a degree during encoding to simplify coding. To convert to tenths of a degree, divide the minutes of both latitude and longitude by 6, and discard the remainder. For example, 43°20'13"N results in 43.3°N (20/6 = 3 remainder 2).

Military Grid Reference System

The Military Grid Reference System is used extensively by all military forces for target information and to locate positions ashore. In a warfare situation, naval guns are aimed by using the grid system, and weather observers may be tasked with providing environmental information for shore targets referenced by the grid system. In NBC warfare situations and in warfare situations requiring electro-optical or electromagnetic support, targets areas are commonly referenced in the grid system.

The Military Grid Reference System uses two separate grids to locate positions: the Universal Transverse Mercator (UTM) grid and the Universal Polar Stereographic (UPS) grid system. Nearly every military topographic chart at scales 1:50,000 and smaller already contain the military grid and geographical coordinate systems.

UNIVERSAL TRANSVERSE MERCATOR GRID.—The UTM grid system is a series of grid zone rectangles measuring 8° latitude by 6° longitude that covers earth from 80°S latitude to 84°N latitude (fig. 4-2). Columns of grid zones are numbered sequentially beginning at 180° and progressing eastward. Rows of grid zones are lettered beginning with *C* at 80°S extending northward. The letters *I* and *O* are omitted to avoid confusion with the numbers *1* and *O*. The northern-most row of grid zones, identified as row *X*, extends from 72°N to 84°N and is the only row that is not equal to 8° latitude in height. A grid zone is identified by the column number followed by the row letter, such as *34P*, which is shown shaded in the figure.

Next, each grid zone is subdivided into 100,000 meter (100 kilometer) squares, called 100,000-meter squares (fig. 4-3, view A). The 100,000-meter squares are identified by two letters. Again, the letters *I* and *0* are omitted to avoid confusion. The rest of the letters, *A* through *V*, are used to identify columns of the 100,000-meter squares, starting at 180° and extending eastward. These 20 letters are repeated every 18° longitude (every three grid zones west to east). The horizontal rows are identified from the equator northward with the letters *A* through *V*, and from the equator southward in reverse alphabetical order by the letters *V* through *A*. In the north-south orientation, there are nine 100,000-meter grid square rows in each 8° grid-zone row. In figure 4-3, view A, the shaded 100,000-meter square is identified by the grid zone (*34P*), then the column-letter (*D*), followed by the row-letter (*M)—34PDM.*

Next, note that each 100,000-meter grid square is divided into 10 rows and 10 columns, resulting in 10,000-meter squares, as shown in figure 4-3, view B. These squares are identified by the numbers 0 to 9 from the western-most line eastward, and then from the southern-most line northward. Point A would be referenced by the grid zone (34P), the 100,000-meter designation (DM), plus the column number (7), and row number (3)—34PDM 73.

Then, each 10,000-meter square is divided into 10 rows and 10 columns to form 1,000-meter squares, as shown in figure 4-3, view C. Again, the columns are identified from the western-most line eastward with the numbers 0 to 9, and the rows are identified from the southern-most line northward with the numbers 0 to 9. Point B is identified by the grid zone (34P), the 100,000-meter-square letters (DM), the 10,000-meter-square column number (7), followed by the 1,000-meter-square column number (6), then the 10,000-meter-square row number (3), followed by the 1,000-meter-square row number (l)—34PDM 7631.

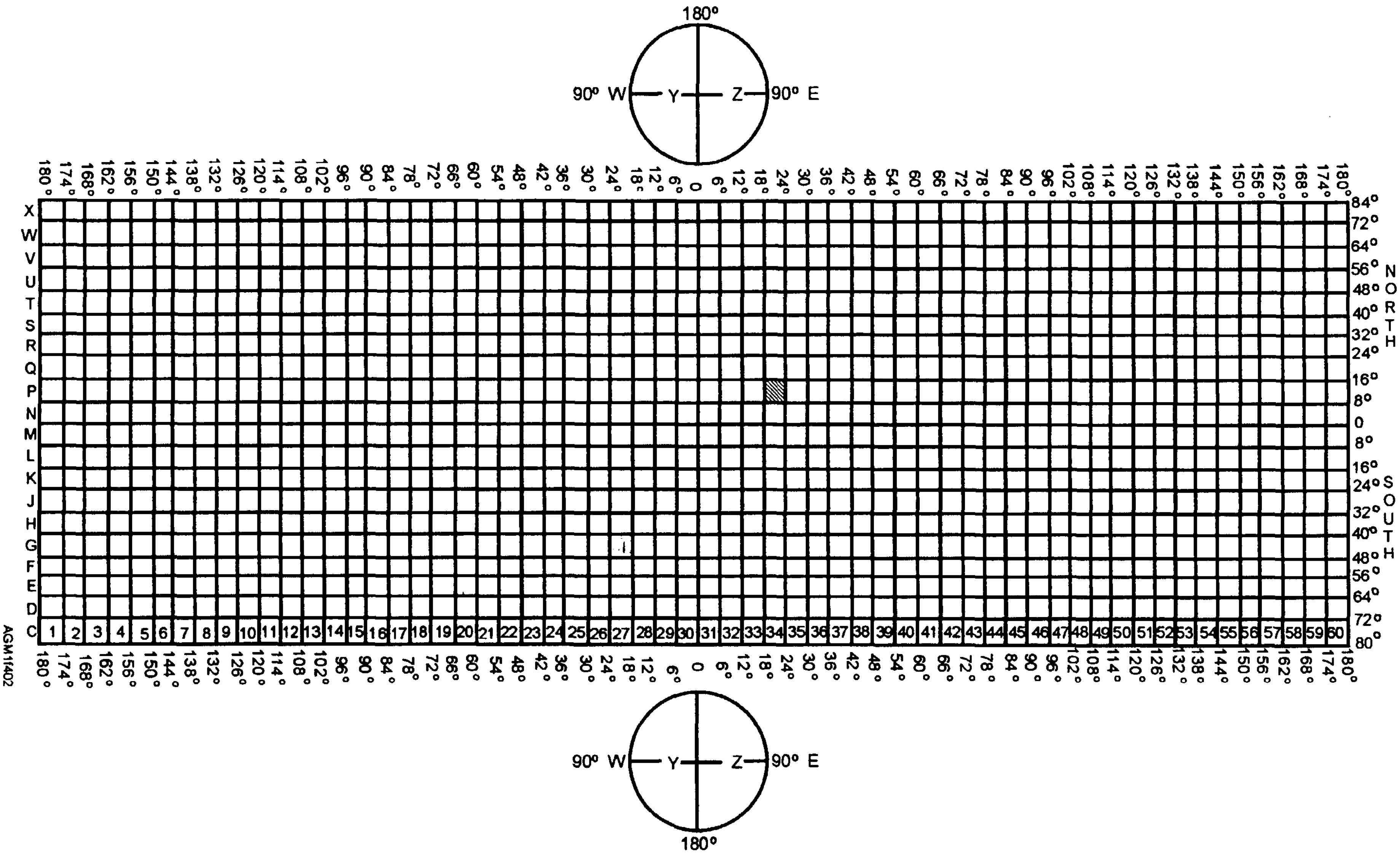


Figure 4-2.—Military Grid Reference System using Universal Transverse Mercator (UTM) grid between 84°N and 80°S latitudes and Universal Polar Stereographic (UPS) grids in the polar regions. Grid squares are identified with the column number first, and then the row letter.

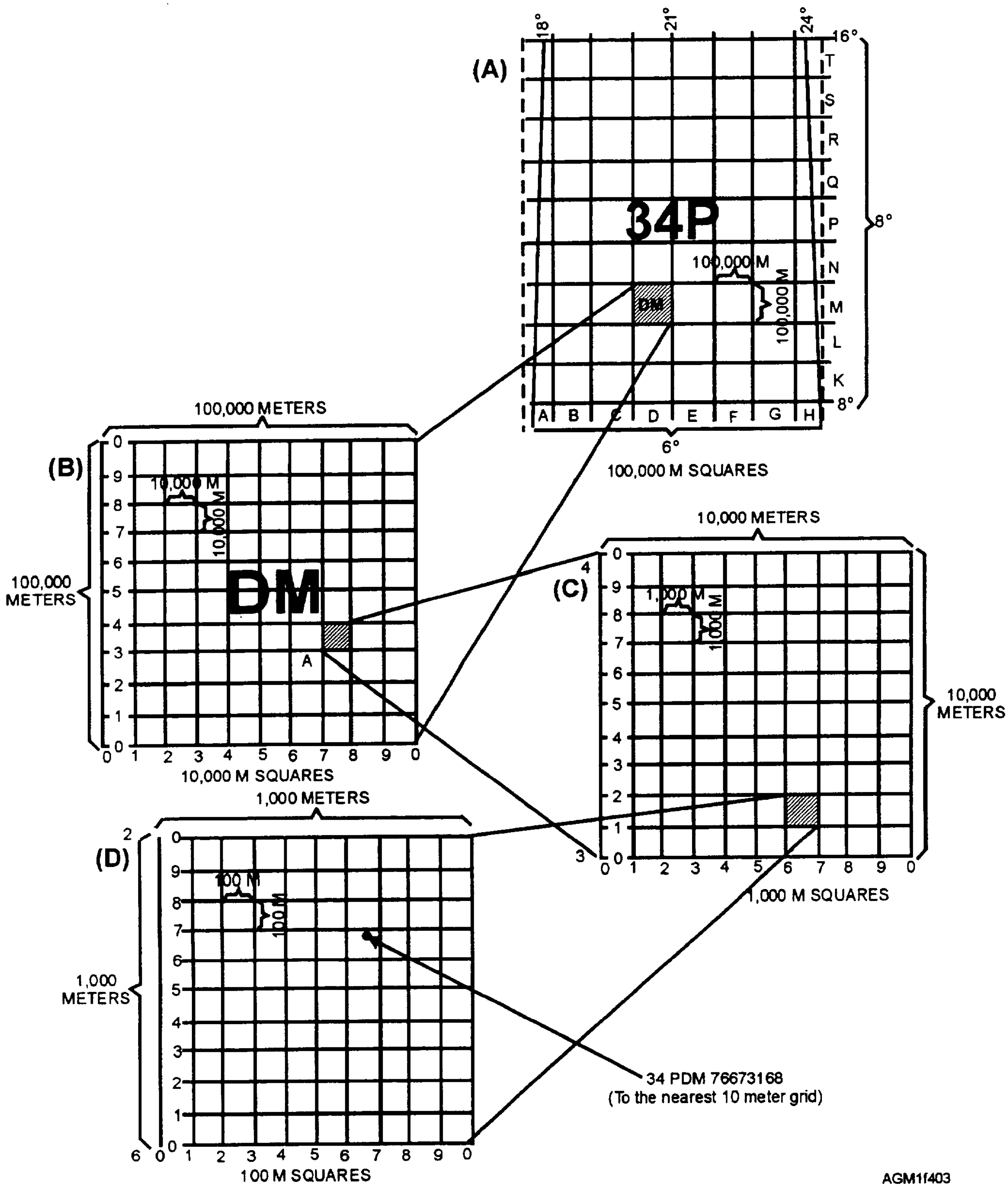


Figure 4-3.—Relationship between grid zone and 100,000-meter squares (view A), 10,000-meter squares (view B), 1,000-meter squares (view C), and 100-meter squares (view D).

This pattern of subdividing the squares and identifying the point with successively smaller columns, and then row numbers may continue indefinitely, but is normally only carried out to the nearest lo-meter square for a precision targeted position. A 10-meter position would have eight digits following the letters, such as 34PDM 76673168, as shown in figure 4-3, view D. To read this position, mentally divide the number into two groups of four digits (7667 / 3168). Think of it as moving eastward from the west side of the DM 100,000-meter grid boundary by (7) 10,000-meter-square subgrids, then (6) 1,000-meter-square grids, then (6) 100-meter-square grids, then (7) lo-meter-square grids. Then, move northward from the southern boundary of the DM grid (3) 10,000-meter grid squares, then (1) 1,000-meter grid square, then (6) 100-meter grid squares, and then (8) 10-meter grid squares.

When military units pass positions in message traffic within a region, frequently the grid zone designation is left out of the position, such as DM 40132879. This practice is common within NATO military forces in Europe.

Now let's look for a moment at figure 4-4. Since the east and west boundaries of each grid zone are specified longitude lines and the 100,000-meter squares (fig. 4-3, view A) are actual distances on earth, the 100,000-meter squares along the edges of each grid zone overlap as the longitude lines converge near the poles. Overlapping portions are truncated at the grid zone boundaries, and the charted grid zones appear to have some partial 100,000-meter squares. When identifying locations, remember that the lettering or numbering system assumes that the missing or partial portions of the 100,000-meter squares are intact.

Notice that the 100,000-meter grid lines are only parallel to the longitude lines near the center of each grid zone. This means the grid lines are oriented slightly westward of true north in the east half of a grid zone, and eastward of true north in the west half of a grid zone. The grid column lines are used as a reference called "grid north" (GN).

The UTM grid lines drawn on a chart depend on the scale of the chart. Figure 4-5 shows a portion of a coastal chart with grid lines drawn every 200 meters. On this chart, the grid location may be easily estimated to the nearest 10 meters. Based on the latitude and longitude, the grid zone is 20Q and the 100,000-meter square is PC. The numbers indicate the 10,000-meter grid coordinates. The lower-left comer of the box marked M is 20QPC 40401040.

While the grid zone designation and the letters of the 100,000-meter square may be used to approximate the general area of a UTM location in geographical coordinates, precise conversions of UTM grid coordinates to geographical coordinates must be done by referencing the UTM position on a gridded chart, and

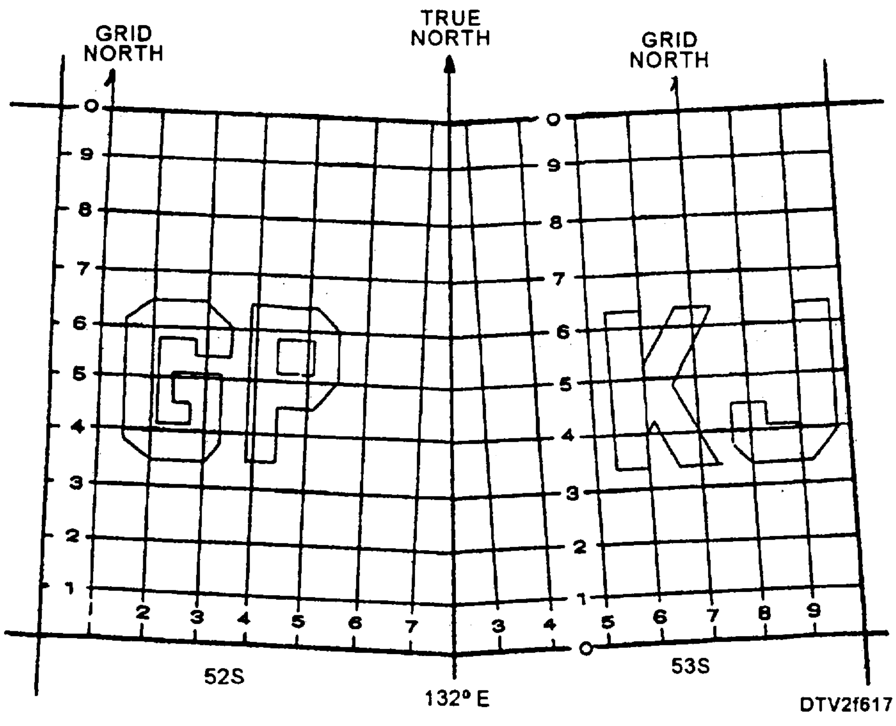


Figure 4-4.—Partial 100,000-meter squares at edges of grid zones.

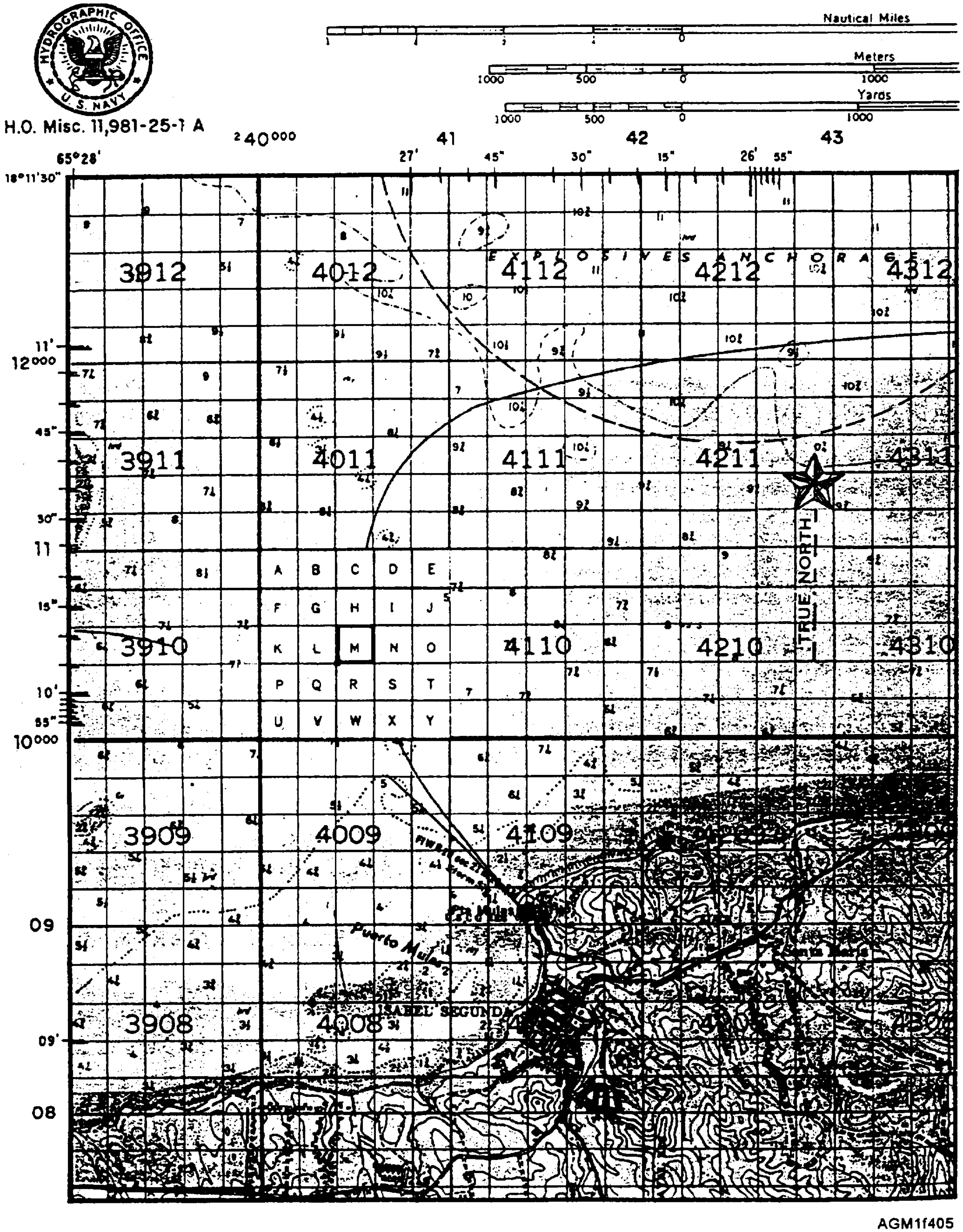


Figure 4-5.—Portion of a naval shore bombardment chart of Vieques Island, Puerto Rico, showing military grid system UTM 10,000-meter, 1,000-meter, and 200-meter grid lines.

then reading the geographical coordinates. On board ship, the Operations Specialist (OS) or Quartermaster (QM) personnel should have a complete set of charts for the ship's operating areas. These personnel should also have the necessary topographic charts for the coastal regions for which weather personnel may need to provide environmental support. Ashore, contact the National Imagery and Mapping Agency regional office or refer to the NIMA catalog for the necessary products.

UPS GRID SYSTEM.—The Universal Polar Stereographic (UPS) grid system is similar to the UTM grid system, except that only two grid zones are used in each polar region: Y and Z in the north polar region, and A and B in the south polar region. Figure 4-6 shows the grid zones and 100,000-meter squares in the north polar region (84°N to the North Pole). For the southern polar region, the grid zone designator A replaces Y, and B replaces Z, and the longitude reference lines are rotated

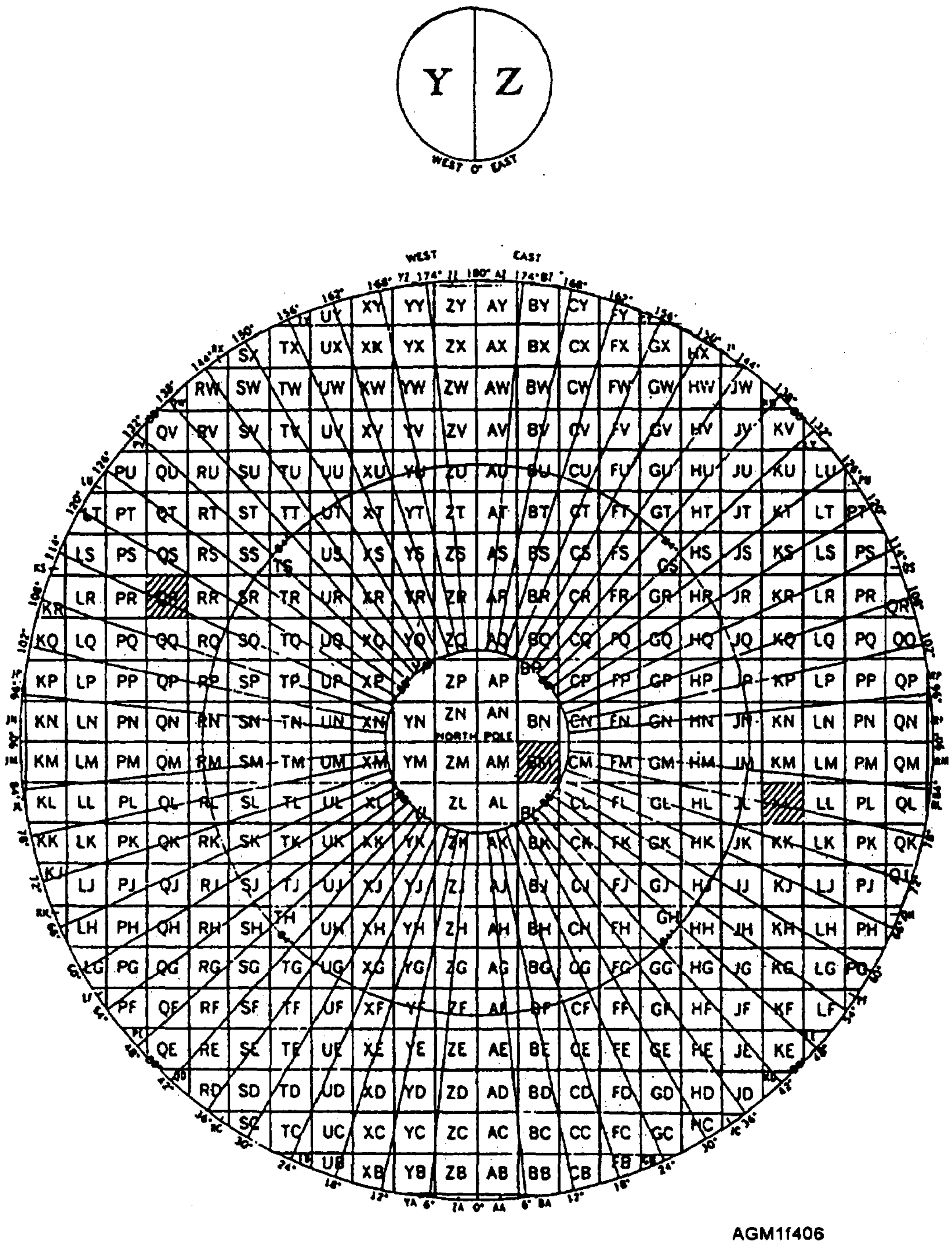


Figure 4-6.—UPS grid zones and 100,000-meter squares used in the polar regions.

180°. The 100,000-meter squares from 80° to 84° are used only in the south polar region.

Because there are no column numbers in the grid zone reference, complete grid locations appear slightly different, such as ZBM 40170.

Within the full and partial 100,000-meter squares, subdivisions into 10,000-meter squares, 1,000-meter squares, and smaller squares are the same as in the UTM system.

MAP PROJECTIONS

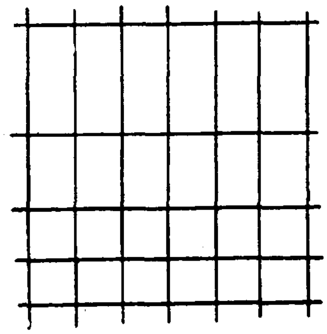
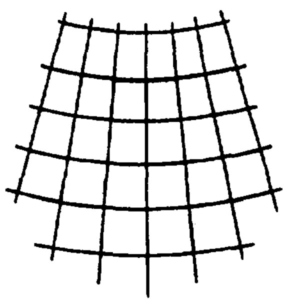
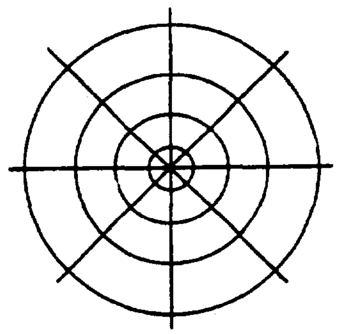
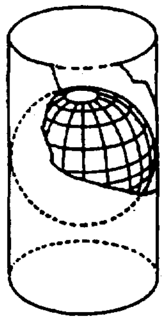
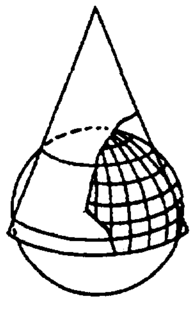
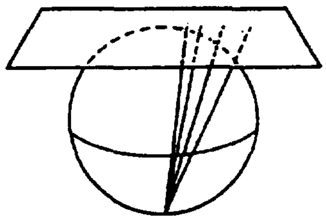
	MERCATOR	LAMBERT CONFORMAL CONIC	POLAR STEREOGRAPHIC
PARALLEL	PARALLEL STRAIGHT LINES UNEQUALLY SPACED.	ARCS OF CONCENTRIC CIRCLES EQUALLY SPACED.	ARCS OF CONCENTRIC CIRCLES UNEQUALLY SPACED.
MERIDIAN	PARALLEL STRAIGHT LINES EQUALLY SPACED.	STRAIGHT LINES CONVERGING AT A POINT OUTSIDE OF MAP.	STRAIGHT LINES RADIATING FROM POLE.
APPEARANCE OF GRATICULE			
PROJECTED ON	CIRCUMSCRIBED CYLINDER 	SECANT CONE 	PLANE TANGENT AT POLE 
PROPERTIES	STRAIGHT LINES ARE RHUMB LINES. CONFORMAL. CONVENIENT PLOTTING. TRUE AREAS NOT SHOWN. STRAIGHT LINES NOT GREAT CIRCLES. TRUE DISTANCES NOT SHOWN. GREAT DISTORTION IN HIGH LATITUDES.	TRUE SHAPES. AREAS GOOD. DISTANCE GOOD. TRUE DIRECTIONS. SMALL NORTH-SOUTH LIMIT OF PROJECTION FOR ACCURACY. PLOTTING FAIR. NOT SATISFACTORY FOR AREAS CLOSE TO EQUATOR.	TRUE SHAPE. ONLY AZIMUTHAL PROJECTION WITH NO ANGULAR DISTORTION. TRUE AREAS NOT SHOWN. SCALE INCREASES IN ALL DIRECTIONS FROM CENTER.
USES	USED FOR AREAS CENTERED IN TROPICAL LATITUDES.	USED FOR AREAS CENTERED IN MIDDLE LATITUDES.	USED FOR NORTHERN AND SOUTHERN HEMISPHERE HIGH LATITUDES.

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Figure 4-7.—Meteorological chart projections.

REVIEW QUESTIONS

Q1. *Name the two coordinate systems used by the U.S. military?*

Q2. *On most charts, 60 nautical miles equals how many degrees of latitude?*

Q3. *Convert 23.54N and 120.38W to tenths of a degree.*

Q4. *When you use the Universal Transverse Mercator (UTM) grid, how is a grid zone identified?*

Q5. *Grid zone 27R is between what latitude and longitude?*

Q6. *What is normally the smallest grid zone used with the UTM grid system?*

Q7. *The Universal Polar Stereographic (UPS) grid system is used in what region of the globe?*

AREAS OF THE GLOBE

In meteorology and oceanography, several terms are used to describe sections of the world. *Northern Hemisphere* refers to the half of earth north of the equator; *Southern Hemisphere* refers to the area south of the equator. Similarly, *Western Hemisphere* refers to the half of earth from the prime meridian westward to the international date line; *Eastern Hemisphere* refers to the half from the prime meridian eastward to the international date line. You will see frequent references to the tropical region, or the Tropics. The Tropics is the belt surrounding earth that lies between the tropic of Cancer at 23½°N and the tropic of Capricorn at 23½°S. In meteorology, however, this region may generally be considered the belt between 30°N and 30°S. Geographically, the area of earth north of the Arctic Circle at 66½°N and south of the Antarctic Circle at 66½°S are the polar regions. Between the Tropics and each polar region lies the area referred to as the middle latitudes (or the mid-latitudes). Based on annual temperature changes, the Tropics, mid-latitudes, and polar regions are also respectively called the *Torrid Zone, the Temperate Zones,* and the *Frigid Zones.* These terms are generally falling into disuse.

CHART PROJECTIONS

Several types of modifications to the shape of earth are made to allow the earth's surface to be represented on flat paper charts and displays. These modifications are called "projections." The most common projections used in meteorology and oceanography are the Mercator projections, Polar Stereographic projections, and the Lambert-Conformal Conic projections, as shown in figure 4-7. Figure 4-7 also indicates the properties of these projections and their intended uses.

You will often see references to great circle routes or tracks. A *great circle* track represents the shortest distance between two points on the surface of earth or on a globe, such as if a string were to be stretched between the two points. Great circle routes are planned on a special chart projection called a gnomonic projection. These projections are similar to polar projections, except the plain of the chart is tangent to the earth at the center of the area charted. Figure 4-8 shows a gnomonic projection with a great circle route and a rhumb line track between two ports. The *rhumb line* track is a straight line drawn between two points on a Mercator projection, and may also be called a "Mercator track." Notice that the great circle route is about 800 nautical miles shorter than the rhumb line track due to the curvature of the earth. Figure 4-9 shows the identical routes drawn on a Mercator projection.

CHART SCALE

The scale of a chart refers to a comparison of the distances shown on a chart to the actual distance on the surface of earth. A scale may be a comparative ratio

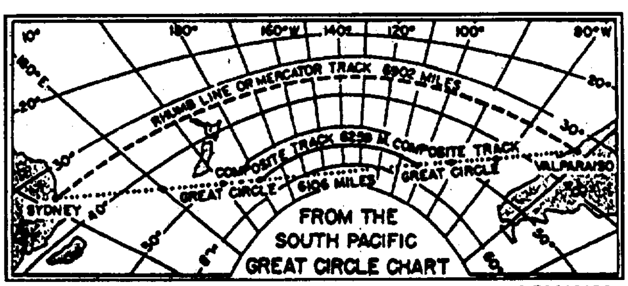

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Figure 4-8.—Rhumb line and great circle tracks on a great circle chart (gnomonic projection).

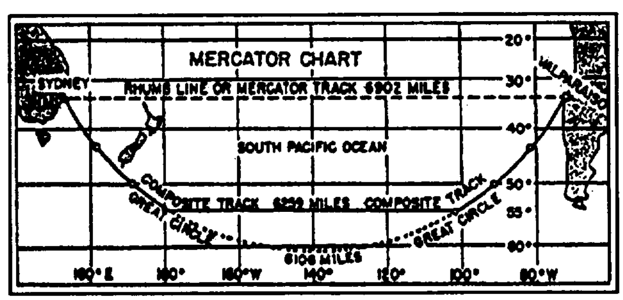

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Figure 4-9.—Rhumb line and great circle course on a Mercator chart.

scale, such as 1:100,000. This may be taken to mean 1 inch on the chart is equal to 100,000 actual inches on the surface of earth, or it may be interpreted as 1 meter on the chart is equal to 100,000 meters on the surface of earth. The scale may also be a distance scale, such as 1 inch = I mile or 1 centimeter = 10 kilometers, as commonly seen on road maps. The military uses the comparative ratio scale. A chart covering a relatively small area is called a small-scale chart, while a chart covering a relative large area is called a large-scale chart.

Typically, weather plotting charts range in scale from 1:1,000,000 for 3-foot by 4-foot charts of individual small countries, through 1:4,000,000 for charts showing sections of the United States. Table size charts for an entire hemisphere may be on a scale of 1:30,000,000.

TYPES OF CHARTS

There are nearly as many types of charts as there are applications for charts. The National Imagery and Mapping Agency Hydrographic/Topographic Center produces a large portion of the charts routinely used by the military. Their seven-part catalog, the *National Imagery and Mapping Agency (NIMA) Catalog of Maps, Charts, and Related Products*, provides a listing of the various charts available, as well as ordering information. The catalog Part I, *Aerospace Products,* Volume 1, contains listings for aeronautical charts-charts displaying air routes and navigational aids used for flight route planning. Volume 2 contains listings for weather plotting charts-charts showing gross topography and land/water boundaries with station circles for established weather stations. Part II of the catalog contains listings for various hydrographic charts-charts used for surface and subsurface marine navigation. These charts show sounded water depths and ocean depth contour lines as well as positions of marine navigation aids. Part III contains several volumes listing various topographic charts-charts showing detailed height contours and structures on land areas used for various types ofplanning. Many volumes are classified.

At some point in your career, you will use aeronautical charts, hydrographic charts, and topographic charts. Up until recently, every observer manually plotted many different types of observations on weather plotting charts. Although you may still on occasion, manually plot data on a weather plotting chart, and therefore should be familiar with the various charts available, nearly all charts used by analysts and forecasters today are computer plotted. Refer to Part I, Volume II, of the NIMA catalog for a listing of the various weather plotting charts available for manual plotting of data.

STATION IDENTIFIERS

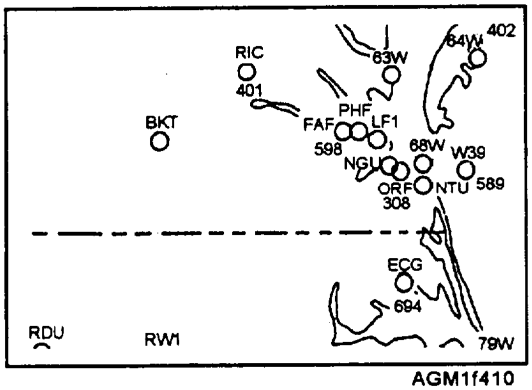
Meteorological stations, when reporting weather conditions, use either a WMO block/station number or station-identifier letters. The station identifier letters are usually the International Civil Aviation Organization (ICAO) assigned station identifier, but may be an identifier assigned by the individual country. A particular station may use its WMO block/station number to report synoptic observations, but use either the ICAO identifier or the nationally assigned identifier to report weather locally.

National Imagery and Mapping Agency weather plotting charts (DOD WPCs) have predrawn station circles for nearly every known permanent weather-reporting station. Each station circle is identified with the WMO station number and/or the ICAO letter identifier, as shown in figure 4-10, view A. Mobile weather reporting stations, such as ships or temporary research sites, report location by latitude and longitude. A station circle must be added at the correct location whenever a mobile station's report is plotted.

WMO Block/Station Identification Numbers

WMO block/station numbers are used to identify locations of permanent weather reporting stations. WMO international block/station identification numbers are a series of six digits. The first two digits are the WMO block number, and the last four digits are the station number. In an area the size of a small city, the designated Synoptic Station—the single station assigned the responsibility to submit synoptic observation reports, has a four-digit station number ending in a zero. Other weather observation sites in the city that are not designated synoptic reporting sites have other numbers as the last digit. For example, figure 4-10, view B, shows the stations in the Norfolk, Virginia area. Norfolk International Airport (ORF), block/station number 723080, is the designated synoptic reporting station.

Since the last digit of the synoptic station's station number is always zero, the last digit is dropped when encoding. Additionally, weather plotting charts only indicate the first three digits of the four-digit station number, such as 308, instead of 3080, adjacent to a synoptic station circle.



(A)

WMO STATION NUMBER	U.S. STATION ID	STATION NAME
723080	ORF	NORFOLKINTERNATIONAL
723085	NGU	NORFOLK NAS
723086	PHF	NEWPORT NEWS
723087	FAF	FORT EUSTIS/FELKER
723088	63W	MILFORD HAV EN CGS

(B)

Figure 4-10.—View (A) is a section of a 1:4,000,000 scale DOD WPC (shown just smaller than actual size), and view (B), WMO international station identification numbers and U.S. national station identification letters in the Norfolk, Virginia vicinity.

WMO block numbers are indicated on the plotting charts, usually in large, pastel blue digits. And the boundaries of each block are drawn as thin pastel blue lines.

A complete numerical listing of WMO block/station numbers is contained in the *Master Weather Station Catalog* available via the Bulletin Board System (BBS) from FNMOD Tinker AFB, Oklahoma. The publication contains listings of country names cross-referenced to block number. The information provided for each station includes latitude, longitude, elevation, information on the coordinates and elevation of the upper-air observation site, and the type of data and observations available. The codes used in the listings are explained in the first section of the publication.

Other station circles may be drawn on the same chart, but identified with either a four-letter ICAO station identifier, such as EGUN, outside of the United States, or a three-letter (or letter/number) national station identifier, such as NGU or 63W within the United States.

ICAO Station Identifiers

Within most countries, except the United States, airfields and their weather observation sites are identified with a four-letter identifier assigned by the International Civil Aviation Organization (ICAO). The first letter is a regional identifier. The regional identifier is used to identify specific groups of countries in geographical areas of the world, such as M for the Caribbean and Mexico, K for the United States, or P for the Pacific. The second letter is specific to a particular country in the region, although a single large country may use several different letters as the second letter in the airfield identifier. For example, in Southeast Asia, Thailand uses ICAO four-letter identifiers beginning with the region identifier V, followed by the country identifier T. For example, Don Muong Airport, Bangkok, Thailand is VTBD. No particular relationship exists between the ICAO identifier and the city name or airfield name.

Within the Unites States, most airfields that report aviation weather use the three-letter national airfield identifiers, such as DAB for Daytona Beach Regional Airport, Daytona Beach, Florida, or BIS for Bismarck Municipal Airport, Bismarck, North Dakota, as the weather station identifier. Most of these identifiers, assigned by the Federal Aviation Administration (FAA), are similar to the city or airfield name. Naval and Marine Corps air stations are nearly all identified by a three-letter identifier beginning with an N. Many automated weather reporting stations are identified by three-letter/number combinations, such as 63W, as seen in figure 4-10. Several years ago, the FAA assigned the three-letter/number identifiers to heliports and airfields that were not manned by air-traffic controllers. Even though some of these stations do provide weather observations, many do not. (Currently, the FAA assigns unmanned airfields a combination two-letter, two-number identifier.)

In the United States, ICAO identifiers were made by simply prefixing the three-letter national identifier with the ICAO region identifier K. Airfields equipped to handle international air traffic use the ICAO identifier as both an airfield identifier and as a communications identifier for weather observations and forecasts. For example: KBIX (Keesler Air Force Base, Biloxi, Mississippi), KJFK (John F Kennedy International Airport, New York City), and KLAX (Los Angeles International Airport, Los Angeles, California) are ICAO identifiers used both to identify the station and weather products originated at the station.

Radio-navigation aids may be co-located at an airfield or be located some distance away from an airfield. These aids are identified by three-letter station identifiers. In most, but not all cases, the radio navigation aid identifier is the same as the airfield's national station identifier.

Converting Station Identifier To Location

Overseas ICAO identifiers may be cross-referenced to WMO block/station numbers and latitude/longitude by using the weather station catalog. OPARS (U.S. Navy Optimum Path Aircraft Routing System) subscribers may use the OPARS Data Base computer listing of location identifiers to cross-reference identifiers. The OPARS Data Base is the most comprehensive listing of identifiers, and is available either as a set of computer printouts, or is accessible via the OPARS computer bulletin board.

For all stations in North America and for selected Department of Defense overseas locations, FAA Order 7350.6, *Location Identifiers,* contains alphabetical name to identifier cross-references as well as alphanumeric identifiers to name cross-reference sections. The listings also include radio navigation aids. The ICAO region identifier, K, is not considered in this publication. Latitudes/longitudes are not provided.

For many countries, the DOD Flight Information Publications (En route), *IFR Supplement (Country Name),* provide alphabetical listings of airfield names andnavigation aid names. Each airfield listing provides the latitude/longitude, station elevation, and station identifier, the time zone of the airfield, communication frequencies, and navigation aid station identifiers and frequencies.

REVIEW QUESTIONS

Q8. What is the geographic definition of the tropics?

Q9. Why are great circle routes generally shorter than straight line Mercator tracks?

Q10. Which of the following scales would show greater detail; a 1:100,000 scale chart or a 1:10,000 scale chart?

Q11. What federal agency is responsible for producing maps and charts for the U.S. military?

Q12. What publication contains a listing of available weather plotting charts and hydrographic charts?

Q13. What is the significance of a WMO block/station number ending with the digit zero?

Q14. Where can a complete listing of WMO block/station numbers be found?

Q15. What is the ICAO region identifier for the United States?

Q16. What publication contains a complete listing of all station identifiers in North America?

GRAPHIC ENVIRONMENTAL PRODUCTS

LEARNING OBJECTIVES: Identify the terms used to discuss graphic meteorological and oceanographic products. Explain how legends are used to identify information presented on a graphic product. Discuss how history is displayed on a graphic product. Identify the standard representation for various meteorological parameters on graphic displays. Identify each element in a plotted meteorological report.

The majority of meteorological and oceanographic products in use are computer-produced graphic products. While nearly all of these graphic products may be reproduced on paper as a hard copy, they are designed primarily to be used in an almost paperless environment directly on a computer video display. These graphics are commonly called charts-a holdover from the time when everything was plotted on weather plotting charts or maps-referring to the geopolitical background used for location reference on graphic weather products. Many types of information may be transferred to the computer via radio, satellite link, telephone modem, telephone facsimile, LAN, or by mail or courier service on floppy or laser disk. The graphic products received by any of these methods may be in the form of digital data fields or actual graphics. Most of the graphics received are intended to be nothing more than "tools" for the forecaster to use to determine the state of the current environmental conditions or the anticipated state of conditions at some time in the future.

TERMS

A product that shows the state of the current conditions or the state of the conditions at some time in the past is called an *analysis.* A product that shows the anticipated state of conditions at some time in the future is called a *prognosis.* These terms are commonly abbreviated as *anal* and *prog,* respectively, both verbally and in text. *Outlook* and *forecast* are sometimes used interchangeably with *prognosis.* Correctly used, however, *forecast* refers to a forecaster's written or verbal interpretation of calculated graphic or alphanumeric products depicting the position and orientation of pressure centers, fronts, isobars and isoheights, etc., and *prognosis* refers to the graphic or alphanumeric product depicting those conditions. Likewise, *outlook* refers to the forecaster's interpretation of a prognosis, typically 3 to 10 days in the future, where the calculated information has a high probability of changing based on the presence of minor fluctuations in the conditions that cannot be accurately anticipated. *Outlook* implies a lower level of confidence or reliability than *forecast.* Certain graphic products depict the forecaster's interpretation of the state of the atmosphere, such as a Horizontal Weather Depiction, and is properly called a *forecast.*

The difference between graphic forecast products and prognosis products is important. You will occasionally be asked to explain certain features on graphic products. This is typically done at stations where a certified forecaster is on duty only during the day but an observer is on duty around the clock. You may explain what is actually indicated on a graphic or alphanumeric forecast product, and you may discuss what is actually depicted on analysis and prognosis products. You may not, however, provide your interpretation of how those parameters may effect weather conditions that are not depicted. Likewise, when reproducing a graphic either on paper or a video display, you may not adjust the location of any feature. In both situations your interpretation would be considered a forecast. You may not provide your own forecast until you have been certified as a analyst or forecaster in accordance with the provisions of NAVMETOCCOMINST 1500.2, *Naval Meteorology and Oceanography Command Training and Certification Program.*

Only a few of the literally hundreds of graphic products available are intended to be used, without additional processing, as briefing aids. A *briefing aid* is any product designed primarily to be used in a briefing to assist the explanation of the current and forecast conditions. Briefing aids are frequently enhanced with colors for weather systems, hazardous weather areas, land and water boundaries, and other items of interest. Briefing aids are enhanced with colors so that the person being briefed can easily see the features discussed by the briefer. The standard colors used are discussed later in this section.

GRAPHIC PRODUCT LEGENDS

All graphic meteorological and oceanographic products must have a legend block or legend line that identifies the product and the information presented on the product. A legend block, such as that shown in figure 4-11, is typically found on products received

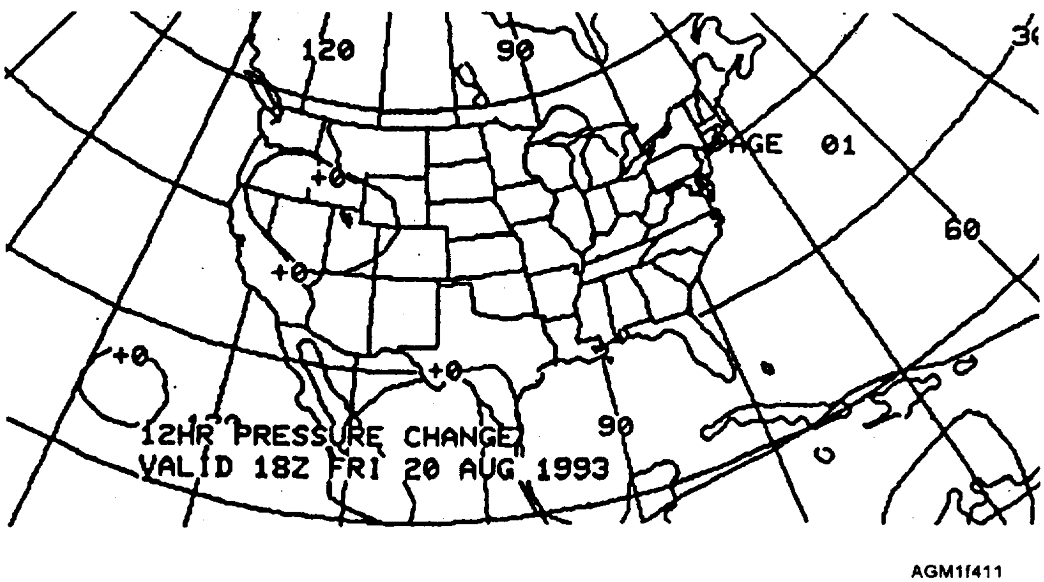


Figure 4-11.—Legend block from a NWS (National Meteorological Center) graphic product.

from the National Weather Service. Products produced by processing data fields received from FNMOC must have a legend line (or lines) added across the bottom or top of the graphic identifying the information displayed. The legend line identifies the product using standard abbreviations and the valid time. For example, an analysis of the surface pressure data field of the 1800Z 12 December 1996 observation data may be identified with a legend line SFC PRESSURE ANALYSIS VALID 08DEC96 1800Z.

The valid time is the UTC date/time that is represented by the information on the graphic. On some products, the valid time is identified with the designation VT: or the word valid; on other products, the date and time are just listed. In the case of an

TERM	SYMBOL	COLOR
Cold front at the surface		BLUE
Cold front aloft		BLUE
Cold front frontogenesis		BLUE
Cold front frontolysis		BLUE
Warm front at the surface		RED
Warm front aloft		RED
Warm front frontogenesis		RED
Warm front frontolysis		RED
Occluded front at the surface		PURPLE
Occluded front aloft		PURPLE
Stationary front at the surface		RED AND BLUE
Stationary front aloft		RED AND BLUE
Stationary front frontolysis		RED AND BLUE
Instability / Squall line		PURPLE
Trough axis		BLACK
Ridge axis		BROWN
Shear line		BLUE
Inter-tropical Convergence Zone		RED
Tropical Wave		BLACK
Jetstream core		RED
High Pressure/height center		BLUE
Low pressure/height center		RED
Tropical Depression center		RED
Tropical Storm center		RED
Hurricane / Typhoon center		RED

Figure 4-12.—Symbols used on surface pressure and constant-pressure level analysis and prognosis charts.

analysis, the valid time is the synoptic hour of the observations. For a prognosis, the valid time is the moment in the future when the actual conditions should be most like the conditions depicted. Certain products are called time-phased products. These products show boundaries of areas that will be effected by moving weather systems over a specified period of time. Time-phased products may either state a valid period of time, such as ACCUM PRECIP PROGNOSIS VT: 2 1 / 1200Z TO 22/1200Z DEC 96, or may indicate the time period in the title, and use a valid time for the end of the period, such as 24HR PRECIP 24 HR FCST VALID 22 DEC 96 1200Z.

When a product is used as a briefing aid, it is common practice to enlarge the valid time on the paper copy or video display so that the audience may see the time without eye strain, and to show both the UTC time and the local time. For a briefing in Norfolk, Virginia (time zone "R"), a briefing product valid at 12Z 18 Dec 96 would be identified with an enlarged valid time of

$$\text{VT: } \left|\frac{\text{1200Z}}{\text{0700R}}\right. \text{ 18 DEC 96}$$

See Appendix III for a chart of time zones.

GRAPHIC HISTORY

Occasionally, you will be asked to place history on a surface chart or a constant pressure level chart prior to manual analysis. History is the past positions of pressure or height centers, fronts, troughs, or ridges. History helps the analyst or forecaster to determine past movements of major chart features. It is a valuable tool in both analysis of the current situation and the prognosis of future positions of the same features.

To place history on a chart, the previous locations of pressure centers or height centers, frontal systems and troughs, and major features, such as jet stream locations, are marked on the chart. Selected isobars, isoheights, or isotherms may also be required by the forecaster. Normally, two sets of positions are placed on a chart: either the 6- and 12-hour-old positions or the 12- and 24-hour-old positions. For instance, a chart containing surface plots of 05 December 1200Z observations may have history marking the past positions of fronts and pressure centers of 5 December at 0000Z (VT minus 12 hours) and 4 December at 1200Z (VT minus 24 hours).

When two sets of history are used, the most recent history positions are marked in orange, while the oldest positions are marked in yellow. If only one set of history is marked, the positions are marked in yellow. Standard symbols are used for all features. The symbols are discussed in the following section.

DATA DEPICTION STANDARDS

Nearly every graphic product that weather observers, analysts, and forecasters deal with is designed either to be received by electrographic methods as ready to use or to be completed by an analyst and sent to another user via electrographic methods. The methods sometimes used to disseminate charted products may be as simple as copying the chart on a photocopier and carrying it to the user. Although some of these methods allow the use of color, many graphics transmission devices operate only in black-and-white mode. Because of this, charts produced on color-capable computer displays normally use standard depictions that combine color and patterns. When charts are reproduced in black and white, the shape of the symbol alone identifies the feature depicted.

Figure 4-12 shows the standard symbols and colors used on surface and constant pressure level analysis and prognosis charts. Figure 4-13 shows the symbols and

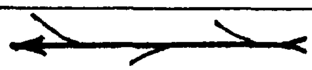
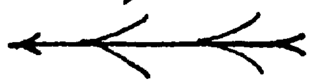
TERM	SYMBOL	COLOR
Divergence line (asymptote)		BLUE
Convergence line (asymptote)		RED
Anticyclonic circulation center	A	BLUE
Cyclonic circulation center	C	RED
Neutral point	col	BLACK

Figure 4-13.—Symbols used on surface and constant-pressure level streamline analysis and prognosis charts.

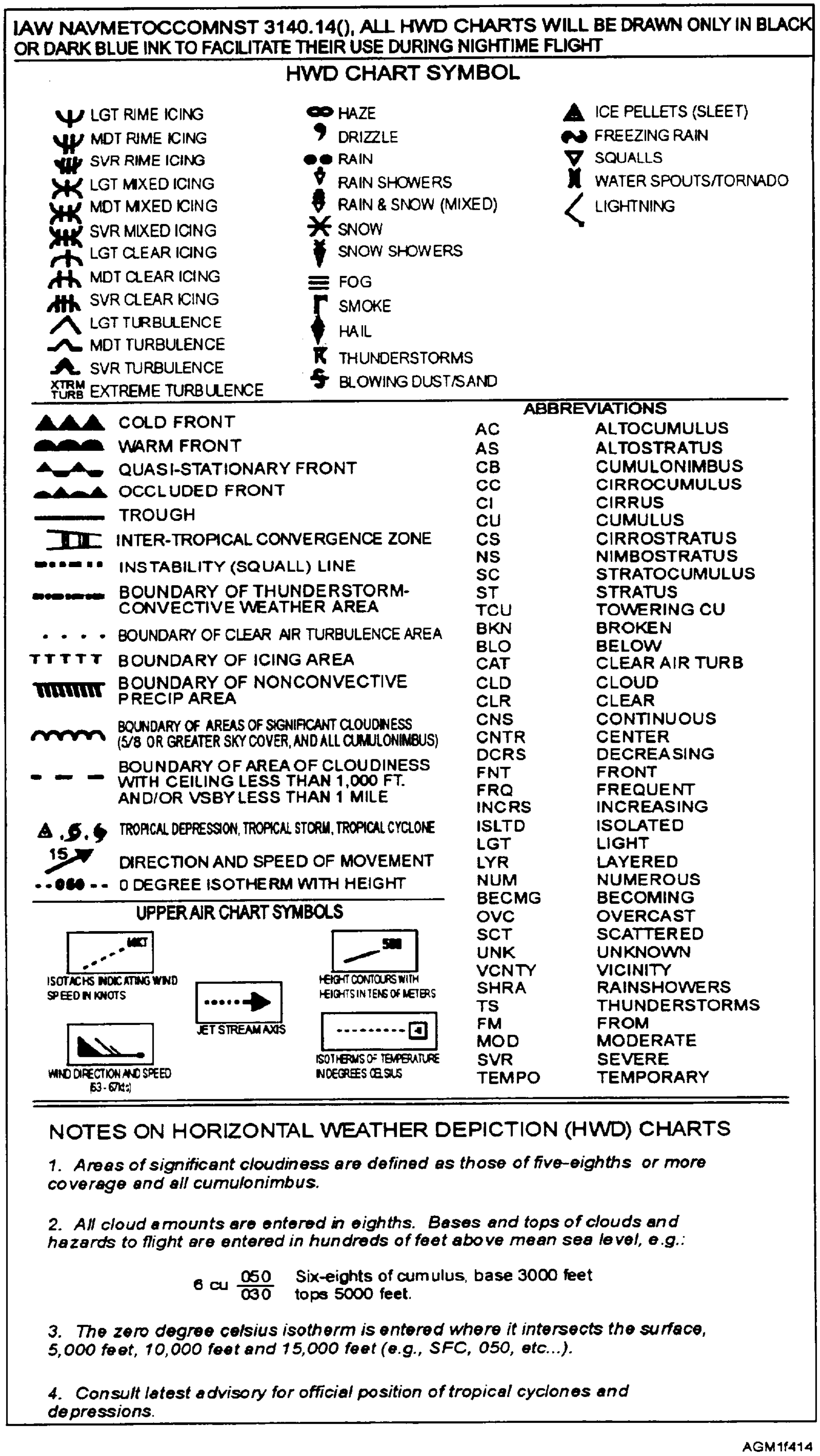


Figure 4-14.—Symbols used on Horizontal Weather Depiction (HWD) analysis and prognosis charts.

colors used on surface and upper level streamline analysis charts. Figure 4-14 shows the symbols and colors generally used on low- and high-level Horizontal Weather Depiction (HWD) analysis and prognosis charts, although there are minor variations. Many of these HWD chart symbols may also be used on surface analysis charts, especially for a small area Local Area Weather Chart (LAWC).

Contour Lines

In addition to standard symbols, most analysis and prognosis charts have one, two, or sometimes several sets of data contour lines displayed. Contour lines normally connect areas with equal data values, so may generally be called "isolines" or "isopleths"-lines of the same value. Normally, the primary set of contour lines is displayed as a solid line, while the secondary contour is displayed as a &shed line. For example, a standard 850-hPa, 24-hour prognosis chart has height contours in solid lines, temperature contours in dashed lines, and wind speed and direction as plotted data. Colors may also be used with contour lines. Normally contour lines are identified with the value at each end, or at the top of closed circular systems, as shown in figure 4-15.

The change in numerical value between each contour line is called the "contour interval." Table 4-1 lists several of the most frequently seen contours, the basic contour value, and the standard contour interval. Sometimes the distance between contours is so wide that intermediate contours are drawn. For example, one intermediate pressure contour using a 2-hPa interval may be drawn between each 4-h.Pa standard interval contour. Intermediate contours are normally dashed lines that are only drawn where they are needed to show a pattern and are normally labeled at each end.

Other Contour Lines

Other contour names not used as often as those in table 4-1 are as follows:

- Isochrone—lines of equal time occurrence of a phenomenon, such as the start or end of rainfall
- Isodrosotherm—lines of equal dew-point temperature
- Isopach—lines of equal thickness
- Isohyet—lines of equal precipitation amount
- Isohume—lines of equal humidity (relative, specific, or mixing ratio)
- Isopycnic—lines of equal or constant density
- Isogon—lines of equal vector quantity, such as wind direction
- Isovel—lines of equal vertical velocity
- Isovort—lines of equal constant absolute vorticity

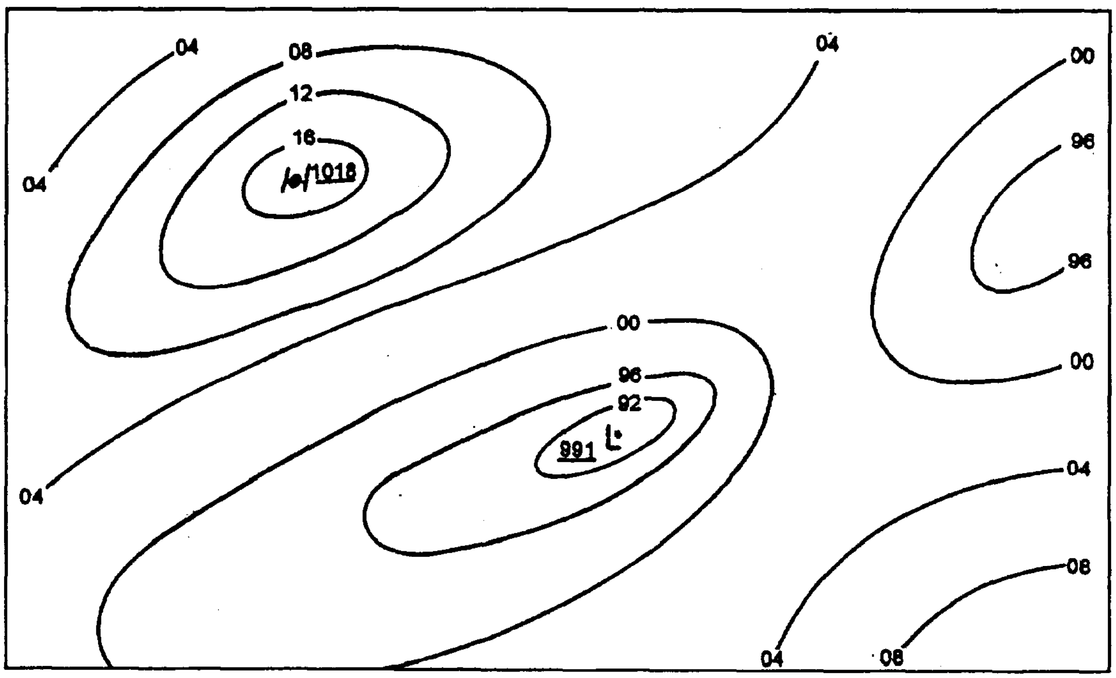


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Figure 4-15.—Labeling of contour line values.

Table 4-1.—Common Contour Names, Standard Values, and Intervals

ISOLINE NAME	DRAWN FOR VALUES OF EQUAL...	BASIC CONTOUR VALUE	STANDARD CONTOUR INTERVAL	EXAMPLE OF CHART USED ON
Isobar	Pressure	04 (1004 hPa)	4 hPa	SFC PRES
Isoheight	Altitude	147 (1470 m) 306 (3060 m) 558 (5580 m) 720 (7200 m) 912 (9120 m) 176 (11760 m)	30 m 30 m 60 m 60 m 120 m 120 m	850-hPa HT 700-hPa HT 500-hPa HT 400-hPa HT 300-hPa HT 200-hPa HT
	Wave height	3 A	3 ft	Wave HT
Isotherm	Temperature	0°C	5°C	850-hPa to 200-hPa TEMP SST
		0°C	2°C	300-hPa & 200-hPa
Isotach	Wind speed	10 kts	20 kts, 50 kts	

- Isallobar—lines of equal pressure change
- Isallohypse—lines of equal height change
- Isallotherm—lines of equal temperature change

REVIEW QUESTIONS

Q17. What is the difference between an outlook and a forecast?

Q18. Define a briefing aid as it pertains to weather forecasting?

Q19. What color is used to mark only one set of history on a chart?

Q20. What colors are used to indicate (a) an occluded front and (b) a shear line, on a surface pressure chart?

Q21. What color is used to indicate a divergent asymptote on a streamline analysis?

Q22. What color is used to indicate (a) clear air turbulence (CAT) and (b) nonconvective continuous frozen precipitation on a horizontal weather depiction analysis?

Q23. What is the standard contour interval used for isobars?

Q24. What is the standard contour interval used for isoheights at 300-hPa?

Q25. What is the standard contour interval used for wave heights?

Q26. What term is used to indicate lines of equal dew-point temperature?

Q27. Lines of equal pressure change are defined what term?

STANDARD DEPICTION OF OBSERVATION REPORTS

In addition to contour lines and weather system depictions, many charts also show plotted wind speeds or plotted observation reports. Standard plotting models are used to guide the placement of information. Plotting models vary slightly by application. There are two synoptic surface observation plotting models: the surface synoptic land observation model and the surface synoptic ship observation model. There is also a synoptic upper-air observation plotting model used to plot reports on all constant pressure level charts. Additionally, there is a METAR observation plotting model, which is a slight variation from the synoptic models and is occasionally used to plot hourly aviation observations.

Observation reports plotted by computers or manually by people use the same plotting models but with one important difference. When a chart is plotted manually, all data in the observation are routinely transferred to the chart, and the single plotted chart is used for many different applications. This is done because manually plotting separate charts is very time-consuming. But when observation data is computer plotted, such as done by the TESS system, only data actually needed for a single type of analysis is routinely displayed. Separate charts may be produced very quickly for each individual analysis, especially since the computer performs the initial analysis. For instance, sea-level pressure, wind speed and direction may be the only parameters plotted for a simple pressure analysis. Only the pressure tendency and change group need be plotted for an isallobaric analysis.

The operator specifies which data to display on the video screen and how the data is to be displayed. The standard plotting models presented in this section should be used as a guide so that the forecaster, when reviewing a "plotted" chart recalled from a saved data file, or a hard-copy of the chart, will be able to interpret the information. These models are also useful in interpreting plotted data received via facsimile on either NWS charts in the United States or from foreign meteorological services.

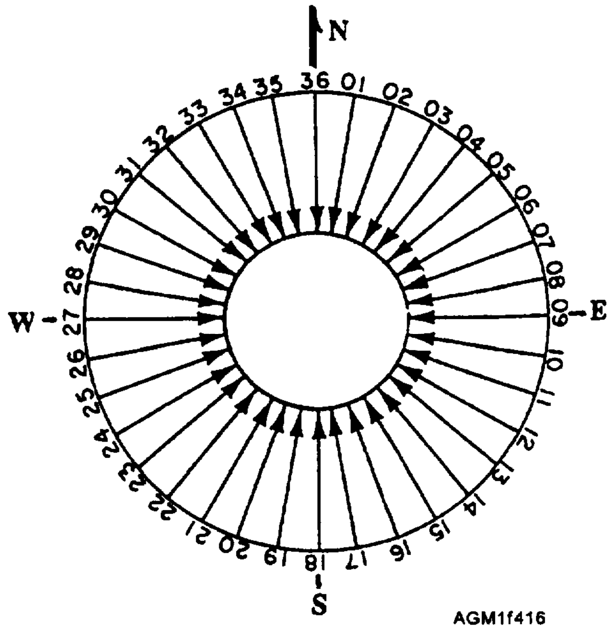


Figure 4-16.—Wind direction in true degrees indicated by the orientation of the wind shaft from the station circle or station location.

Wind Plots

Many prognostic charts show plotted wind directions and speeds. Winds are always plotted with a system of winds shafts and barbs. The direction is indicated by the orientation of the shaft extending from the station circle (fig. 4-16). The wind speed is indicated by the barbs on the shaft and gusts are written at the end of the wind shaft (fig. 4-17).

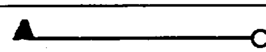
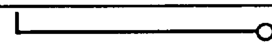
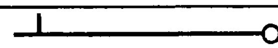
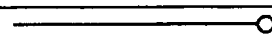
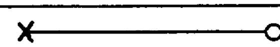
TESS 3.0 only . . . A square is used to indicate each 100 knot increment	
Flagged barb indicates 50 knot increments of wind	
Single barb indicates 10 knot increments	
Half barb indicates 5 knots	
No barbs on shaft indicates less than 3 knots	
An *X* on the end of the shaft indicates a missing wind speed	
An *X* on the center of the shaft indicates a missing wind direction	
A circle drawn around the station circle indicates calm winds	
Wind barbs extending clockwise from the wind shaft, as shown above, are used for plots in the Northern Hemisphere. To plot winds in the Southern Hemisphere, plot wind barbs so that they extend counterclockwise from the wind shaft.	

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Figure 4-17.—Wind speed indicated by barbs. Plotted winds are rounded-off to the nearest 5 knots.

Synoptic Surface Plotting Models

The plotting models for both land stations and ship-reported synoptic surface and upper-air observations are dictated by World Meteorological Organization publication WMO No. 305, Guide on the Global Data-processing System, Volume *II, Preparation of Synoptic Weather Charts and Diagrams.* Plotted observations use symbols, numbers, and letters to depict various reported data. Figure 4-18 shows the symbolic Land Synoptic code, the symbolic plotting model, an actual report, and the plotted report. Figure 4-19 shows the symbolic Ship Synoptic code, the symbolic plotting model, an actual report, and the plotted report.

Normally, only observations from the same synoptic hour are plotted on a chart. If observations from a past synoptic hour say, 0300Z or 0000Z data plotted on a 0600Z chart, the observation hour is plotted below the station model, such as 032 or 00Z. Late reports and off-time reports may be manually plotted on a computer plotted chart to aid reanalysis in data sparse areas. When this is done, late reports corresponding to the synoptic hour of the chart are normally hand plotted in black ink, while older synoptic intermediate reports are plotted in different colored ink, such as blue, red, or green. (Note: red ink or pencil does not show up on a chart under shipboard red lighting and normally does not copy well on a photocopier.)

Quadrant-of-the-globe, latitude, and longitude, or the block and station number in the case of land observations, are not plotted, but are used to locate the station circle.

Several reported values are plotted with a graphic symbol vice the reported numeric value. Total sky cover, N, is indicated by shading portions of the station circle. Present weather, past weather, cloud types, pressure tendency, and the ships course-made-good are also indicated by symbols. These are shown in Appendix IV.

Reported temperatures are rounded off to the nearest whole degree Celsius for land station reports. For ship reports, temperatures are not rounded off, but plotted as they are reported to the nearest tenth degree Celsius. Only the sea-surface temperature contains a decimal point before the tenths value by WMO guidelines.

SYMBOLIC FORM (Data in brackets not routinely reported)

AAXX YYGGi_w IIiii $i_R i_x$hVV Nddff (00fff) 1s_nTTT 2$s_n T_d T_d T_d$ 3$P_o P_o P_o P_o$ 4PPPP (or 4$a_3$hhh) 5appp (6RRRt_R) 7ww$W_1 W_2$ 8$N_h C_L C_M C_H$ 9GGgg 333 0.... 1$s_n T_x T_x T_x$ or 2$s_n T_n T_n T_n$ (3Ejjj 4E'sss 5$j_1 j_2 j_3 j_4$ $j_5 j_6 j_7 j_8 j_9$) 6RRRt_R 7$R_{24} R_{24} R_{24} R_{24}$ 8$N_s C h_s h_s$ 9$S_p S_p s_p s_p$ 444 N'C'H'H'C_t 555;

ACTUAL REPORT

AAXX 07124
72409 21320 80327 10157 20150 39922 49928 57028 76264 87923 91156 333 10183
20091 60175 70031 87923 91038 555 90712;

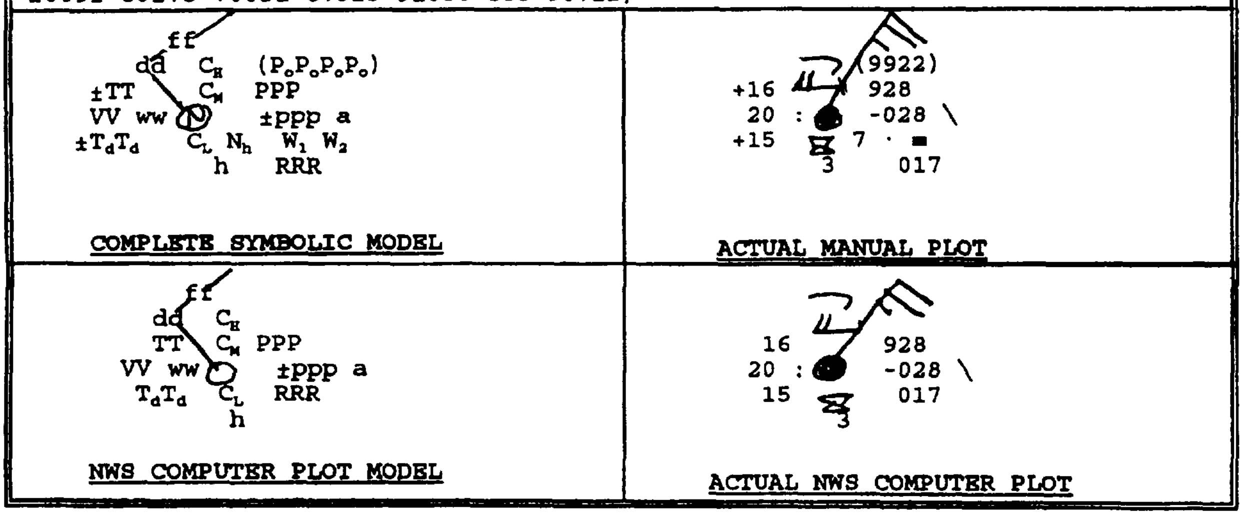

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Figure 4-18.—Synoptic land observation plotting models.

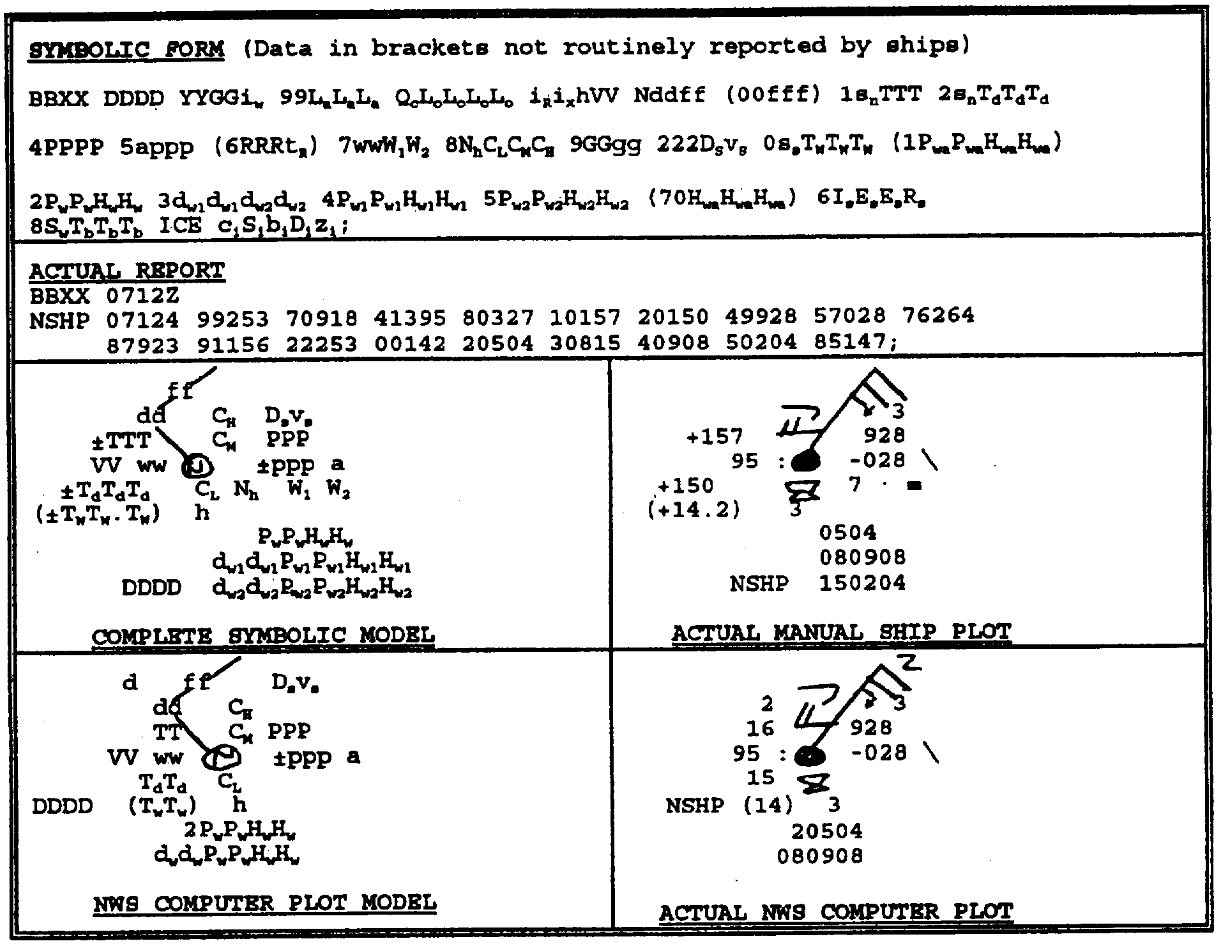

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Figure 4-19.—Synoptic ship observation plotting models.

Synoptic Upper-air Plotting Model

A complete upper-air observation report may be plotted on a single chart—the Skew T, Log P diagram, discussed later in this chapter—or sections of the report pertaining to each standard level may be plotted on the appropriate constant pressure level chart. For an 850-hPa pressure level chart, only the data reported for the 850-hPa level is extracted from each individual observation for plotting. Figure 4-20 shows the

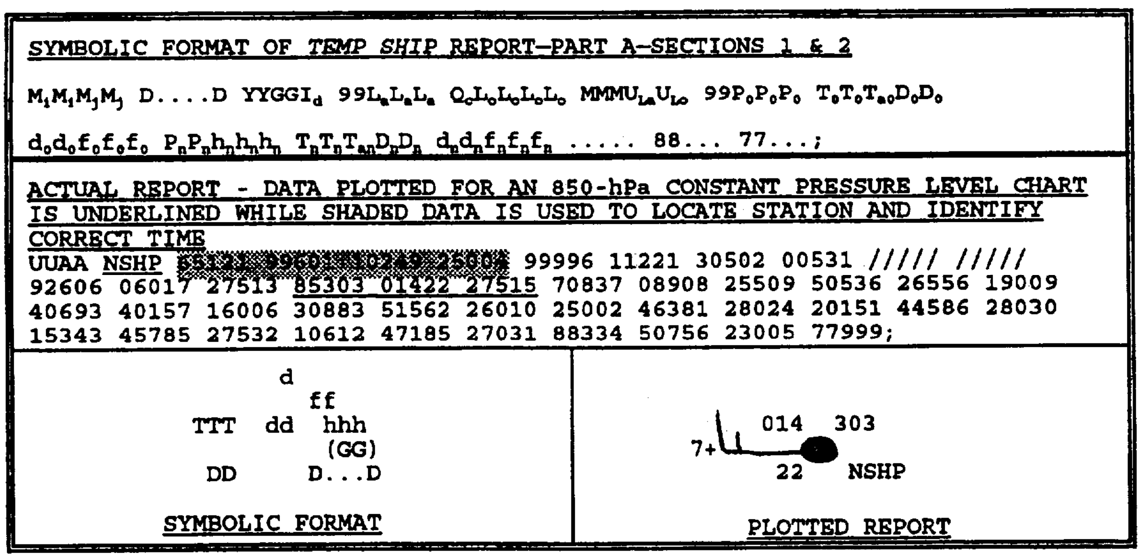


Figure 4-20.—Standard plotting model for constant-pressure level data received in upper-air observation reports.

standard plotting model for upper-air observed data. As an example, we have used a ship observation. A land station report is plotted in the same manner, using the block-station number to locate the station. Block-station number is not plotted.

Notice in the constant pressure level plotting model that the tens digit of the wind direction is normally plotted near the base of the wind barb. A plus sign (+) after the tens of wind direction is used by WMO guidelines to indicate wind directions reported at odd five-degree increments. The hour of the observation GG is plotted in parenthesis to the right of the report only when the report is more then 1 hour off the synoptic chart time. The station circle is filled in when the dew-point depression is less than or equal to 5°C.

REVIEW QUESTIONS

Q28. Besides speed and accuracy, what else is a significant advantage of the TESS computer plotting system?

Q29. What does an 5" on the center of the shafi of a wind plot indicate?

Q30. Where is air temperature information placed on a surface observation plotting model?

Q31. Where is pressure change information placed on a plotting model?

Q32. Where would the observation time be plotted if a particular observation was from a different synoptic period than the overall chart?

Q33. How is total shy cover information indicated on a METAR surface observation plotting model?

Q34. How is ship movement plotted on a ship synoptic model?

Q35. What does a filled in station circle indicate on a constant pressure standard plot?

METAR Plotting Models

The synoptic surface and synoptic constant pressure level plotting models are used every 6 hours to plot data for the synoptic hours. In the United States, the NWS also provides Synoptic Intermediate Surface Analysis charts, so surface analyses are available every 3 hours. Occasionally, a forecaster may need hourly plots of data for small areas. This is usually done to allow the analyst to preform a Local Area Weather Chart (LAWC) analysis. LAWCs are used to track weather features whenever a detailed picture of developing weather conditions is required for a small area, usually only a few states in size. LAWCs are usually not done for ocean areas due to the lack of observations. Figure 4-21 shows the METAR plotting model.

In METAR code plotting, the weather is either plotted in the letter abbreviations as reported, or converted to standard symbology at the forecaster's discretion. See Appendix IV for the standard weather symbology. The first reported cloud layer is plotted above the station circle with each successive layer plotted below the first. If a layer is identified as CB or

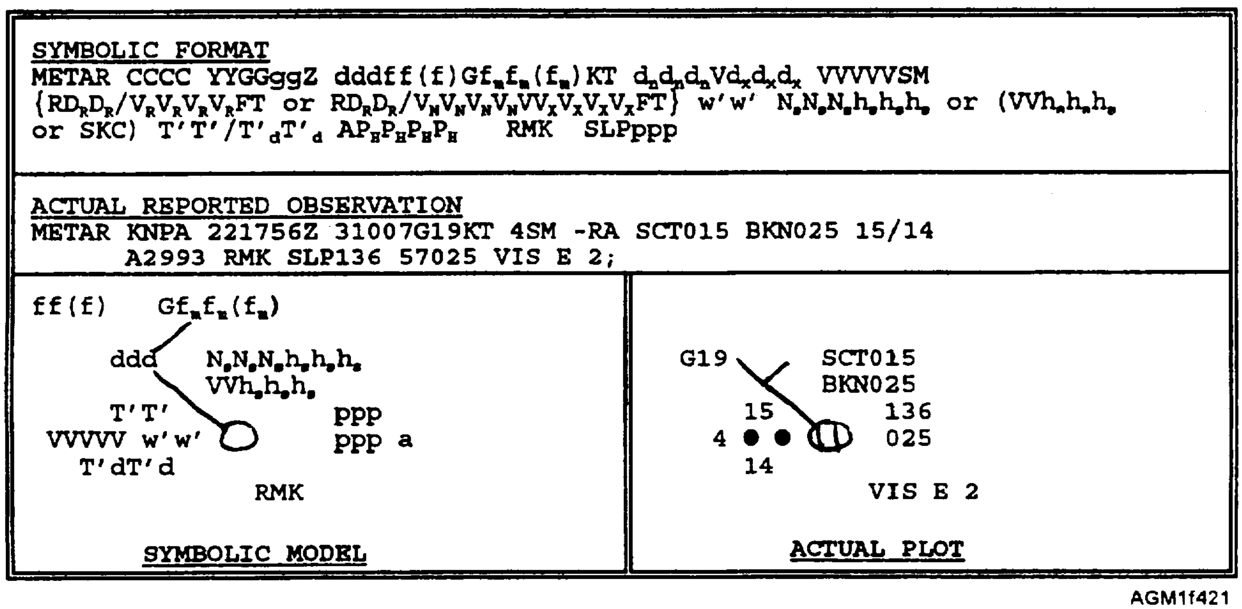


Figure 4-21.—METAR code plottiog model.

TCU, the designation is plotted to the right of the layer height. Total cloud layer coverage is plotted as the symbols 0 for clear (no cloud layers reported), 0 for few or scattered, ⦶ for broken, ⊕ for overcast, or ⊗ for obscured. The sea level pressure in hectopascals is plotted in the upper right of the station circle.

Visibility is plotted in statute miles. Weather may be either plotted in the letter code as reported or converted to standard symbology at the forecaster's discretion (see Appendix IV). If an overseas location reports CAVOK instead of visibility and cloud layers, plot 9999 for visibility and OK to the right of the station circle. Runway visual range and remarks are plotted below and to the right of the station circle.

SEA-SURFACE TEMPERATURE CHART

The sea-surface temperature (SST) chart may be manually plotted or computer-plotted. Reports of satellite-sensed sea-surface temperature or synoptic-observation sea-surface temperatures are used. If plotted by a computer, the chart is routinely supplemented with any and all data available from other sources. An SST chart that uses various sources of information is called a "composite" SST chart. If based on satellite observations, the chart is supplemented with ship synoptic SST reports as well as ship and aircraft bathythermograph observation SSTs. Normally, up to 3 days of collected data is used for a manually plotted SST chart. Only in the most data-sparse areas is it considered acceptable to use reportsup to 10 days old.

The analyst normally draws isotherm contours on the plotted chart at 2-degree Celsius intervals for an SST analysis.

Since both new and older data are used and several types of data are combined, each type and age of data must be identified to allow the analyst to weight each report for accuracy. Data are routinely coded with symbols to indicate both the source and the age of the report. Recent calibrated infrared satellite observations of the sea surface in cloud-free and low-humidity areas are considered the most accurate and reliable. Recent bathythermograph observations are next in accuracy, while recent ship-observed SST reports are least reliable. Satellite observations are usually computer-plotted on the base chart, with the temperature (in degrees Celsius) plotted next to a small square. When supplemented with ship SST observations, the ship-reported SST is plotted following a Day Code symbol, as shown in figure 4-22. For example, ship-reported SSTs from the current day may be plotted as -12.3

DAYS OLD	SYMBOL
Current Day	–
1 day old	Δ
2 days old	∇
3 days old	+
4 days old	×
5 days old	• –
6 days old	• Δ
7 days old	• ∇
8 days old	• +
9 days old	• ×

Figure 4-22.—SST data age plotting symbols.

(12.3°C) or --0.3 (-0.3°C), while a report of an -0.5°C ship-reported SST 3 days old is plotted as +-0.5. Aircraft or ship bathythermograph SST reports are also plotted by following the date codes shown in the table, but the bathythermograph observations are always circled. For example, Δ14.6 indicates a bathythermograph reported 14.6°C SST 1 day old.

If the validity of an SST report is in question, the report is underlined, such as ∇17.7 . If a report is corrected before plotting, the report is double-underlined, such as x22.2.

Enter the symbols and age of the data in a legend block in the top or bottom margin of the chart.

As with the SST chart, there are a few special practices followed with the sea height chart.

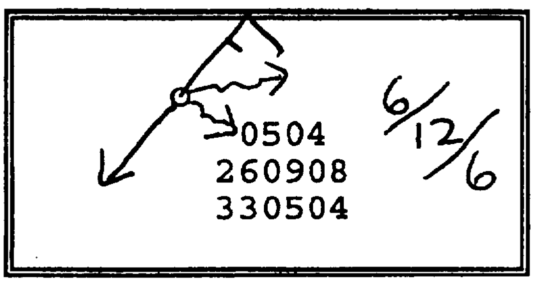
SEA HEIGHT CHART

The sea height chart is usually a computer plot of ship and coastal station locations for a given synoptic time, showing only the wind speed and direction, the sea-wave height group ($P_wP_wH_wH_w$ from the $2P_wP_wH_wH_w$ group), the primary swell-wave direction/period/height group ($d_{w1}d_{w1}P_{w1}P_{w1}H_{w1}H_{w1}$), and the secondary swell-wave direction/period/height group ($d_{w2}d_{w2}P_{w2}P_{w2}H_{w2}H_{w2}$). The computer plotted chart may also have a preliminary pressure analysis printed to aid the analyst. Ship reports received late and classified ship reports may require manual plotting on the chart following the format of the computer plot.

Unless the computer is instructed to convert reported heights in half-meter units to feet, the observer must convert the heights. Heights are converted to feet by multiplying the height in half-meters by 3, then dividing by 2. Converted heights are usually plotted by writing the sea height over the swell height as in a fraction immediately to the right of the plotted report. Figure 4-23 shows a computer-plotted report of the sea and swell waves. The observer has converted the height in half-meter units to height in feet, and has written the converted height to the right of the report.

Sometimes the analyst may ask the observer to draw arrows for the wave directions. When this is required, the observer draws a "straight" arrow pointing away from the station circle directly opposite the wind direction as shown. Since seas are caused by the wind, the direction the seas are moving toward is opposite the wind direction (direction winds are blowing "from"). The swell-wave directions report the direction the swells are coming from. Swell-wave directions are indicated by drawing a "wavy" arrow from the station circle pointing opposite the reported direction. The primary and secondary swell-wave directions (080° and 150°) are drawn above. A shorter wavy arrow is sometimes used to indicate the secondary swell-wave direction.

Two charts are routinely derived from sea- and swell-wave reports: the significant wave height analysis and the combined sea-height analysis. The computer systems at FNMOC routinely produce significant wave height analyses. The combined sea-height analysis is normally analyzed from computer plotted observation data. Aboard ship, sea and swell heights are normally plotted by the TESS system, but are occasionally manually plotted. The analyst may analyze both sea and swell wave directions and heights independently to produce a sea and swell wave analysis, or analyze just the higher of the sea or swell wave heights for a significant wave height analysis. In all types of wave height analyses, isoheight contour lines are drawn at 3-foot intervals, normally as solid black lines. Arrows may be added by the analyst to indicate prevailing wave directions.



AGM1f423

Figure 4-23.—Computer-plotted wave report with observer-entered beight conversions and direction arrows.

The Combined sea-height, often identified as the "C-height," is defined as the square root of the sea-wave height squared plus the swell-wave height squared. The combined sea-height represents an approximation of the height of the highest crests of water formed when the crests of sea waves interact with the crests of swell waves. For example, a reported sea height of 3 feet with a reported swell height of 4 feet would result in a C-height equal to the square root of 3^2 plus 4^2, or 5 feet. If the C-height is not computer-calculated and plotted, the analyst or the observer calculates the values and plots them to the right of each observation plot. This is normally done by using a table that is produced locally.

REVIEW QUESTIONS

Q36. Where are remarks plotted on a METAR code plotting model?

Q37. What does the symbol [64] indicate?

Q38. What does the symbol [13] indicate?

Q39. What does the symbol [22] indicate?

Q40. What is the normal contour interval for an SST analysis?

Q41. How is 4-day old SST information annotated on *an SST analysis?*

Q42. How are sea and swell wave directions depicted on a sea height chart?

SKEW T, LOG P DIAGRAM

LEARNING OBJECTIVES: Identify the scales used to plot reported information on the Skew T, Log P diagram. Discuss how the Pressure Altitude scale is constructed. Describe how reported information is plotted on the diagram and how the temperature, dew-point temperature, and pressure altitude curves are completed by using plotted information.

One of the most useful products for analysis of the state of the atmosphere over a single location is the Skew T, Log P diagram. The standard Skew T, Log P diagram is one of the few products that provides a complete profile of the atmosphere in the vertical, from the surface to as high as 25 hectopascals.

Environmental computer systems, such as TESS, have built in programs that will plot a complete upper-air observation report on a background representative of the Skew T, Log P and calculate many values routinely found by using the diagram. However, the computer plot does not provide the overall detail provided by a paper copy of the Skew T chart. An actual DOD-WPC 9-16 Skew T, Log P Diagram should be available at your command.

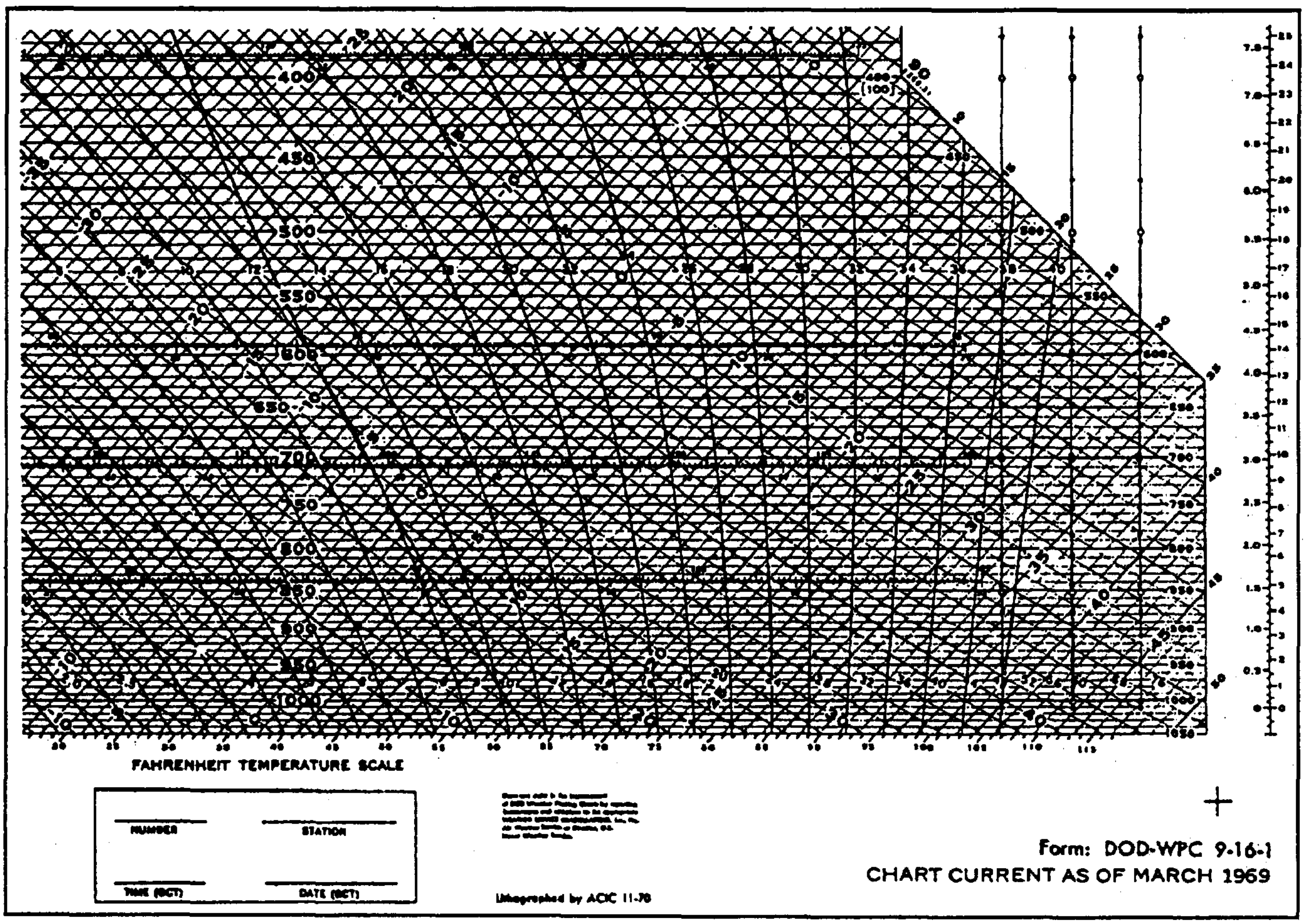
Detailed information on plotting, analysis, and forecasting techniques using the Skew T, Log P diagram is contained in NAVAIR 50-lP-5, *The Use of the Skew T, Log P Diagram in Analysis and Forecasting.*

DIAGRAM FAMILIARIZATION

The Skew T, Log P diagram is a set of curved and straight lines that graphically represent the physical processes that occur in the atmosphere as moist air rises and descends. In the upper-right comer of each diagram is a detailed explanation of each set of lines on the diagram. The Skew T, Log P diagram is printed in black, pastel green, and light brown. DOD WPC (Department of Defense, Weather Plotting Chart) 9-16 is the basic chart. Several different variations of the chart are available and listed in the NIMA Catalog. All versions have the basic plotting scales discussed below, superimposed over each other (fig. 4-24). These scales are used as guides for plotting observed information, and then for deriving other values when analyzing the plotted information. The use of the Skew T, Log P diagram allows analysts to find important values and indicators without having to preform complex thermodynamic calculations.

Isobar Scale

Isobars are lines of equal pressure. The scale is a series of horizontal, solid brown lines spaced logarithmically at 10-hectopascal intervals from 1050



AGM1f424

Figure 4-24.—A portion of a Skew T, Log P diagram (version 9-16-1) showing the superimposed plotting scales.

hPa at the bottom of the chart to 100 hPa at the top (fig. 4-25). Pressure values are printed in the center of the diagram as well as at both the left and right sides. The upper portion of the isobar scale from 400 to 100 hectopascals is also used to plot pressure levels 100 to 25 hectopascals. Most of the mandatory reporting levels are indicated by slightly thicker brown lines. When the station pressure is lower than 1000 hPa, the height of the 1000 hPa surface may be obtained from the nomogram in the upper lefthand comer of the diagram.

Isotherm Scale

Isotherms are lines of equal temperature. The scale is depicted as a series of straight, solid brown, right-diagonal lines (fig. 4-26). Isotherms are evenly spaced at l-degree Celsius intervals ranging from warm temperatures (around 50°C) at the lower right to cold temperatures (near minus 120°C) at the upper left. The temperature range varies on the different versions of the chart. Isotherms are labeled every 5 degrees, and a Fahrenheit temperature conversion scale is printed across the bottom edge of the isotherm scale.

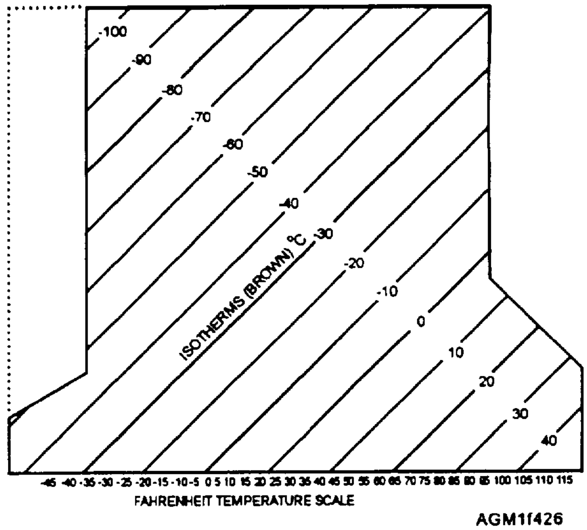


Figure 4-26.—Example of isotherms on a Skew T, Log P diagram.

Dry Adiabat Scale

The dry-adiabatic lapse rate is the rate at which nonsaturated air cools when it rises in the atmosphere, or warms when it subsides.' On the scale, dry adiabats are slightly curved, solid brown, left-diagonal lines at a 2°C interval (fig. 4-27). Values for the dry adiabats are the same as the intersecting isotherm at the 1,000-hPa level, and are printed across the top edge and right side of the diagram.

Saturation Adiabat Scale

The saturation-adiabatic lapse rate (sometimes called a moist-adiabatic lapse rate), is the rate at which saturated air cools when it rises, or warms when it subsides. On the scale, saturation adiabats are solid,

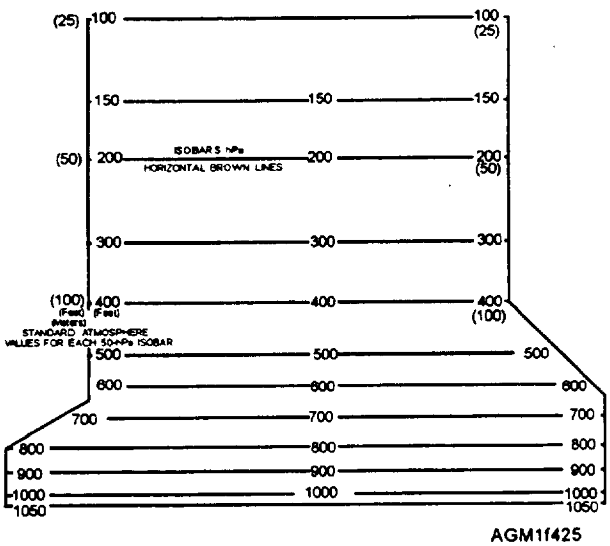


Figure 4-25.—Example of isobars on a Skew T, Log P diagram.

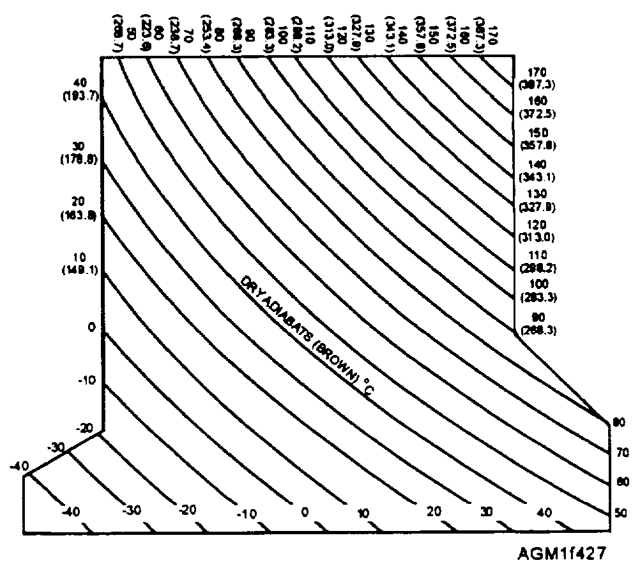


Figure 4-27.—Example of the dry adiabat scale on a Skew T, Log P diagram.

curved green lines (fig. 4-28) at a 2°C interval. Each saturation adiabat is labeled with the Celsius temperature value of its point of intersection with the 1,000-hPa isobar, and is also indicated by the green numbers at the 200-h.Pa level where the scale ends.

Mixing Ratio Lines

The saturation mixing ratio is the greatest amount of water vapor that may be contained in a parcel of air, expressed in units of grams of water vapor kilogram of dry air (g/kg). Dashed, right-diagonal green lines are used to represent various mixing ratio values (fig. 4-29). These values are printed in green between the 1,000-hPa and 950-hPa isobars.

U.S. Standard Atmosphere

The U.S. standard atmosphere is a representation of the annual average temperatures at various levels in the atmosphere for the continental United States. It is shown on the diagram as a heavy brown line (fig. 4-30). The height scale on the right side of the diagram, in both meters and feet, is calibrated to the U.S. Standard Atmosphere. The heights provided on the left side of the diagram under the pressure level labels are based on the U.S. Standard Atmosphere. The values in parenthesis are provided in geopotential feet, while the values in the square brackets [ ] are given in geopotential meters.

Wind Plotting Scale

A wind plotting scale is also provided on the right side of the diagram (fig. 4-30). Three identical wind scales are provided because up to three successive soundings may be plotted on the same diagram. This is

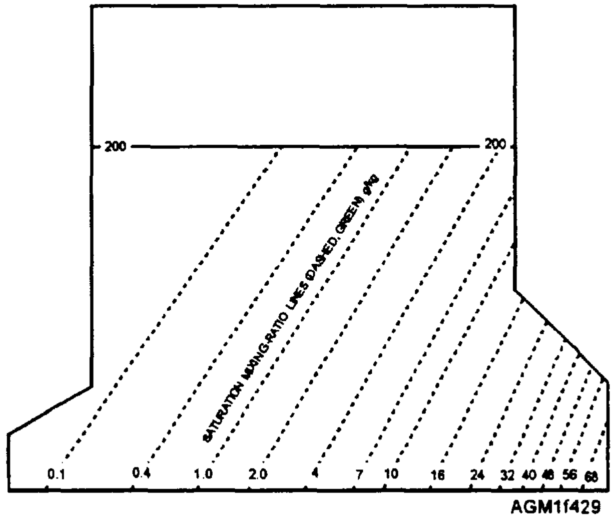


Figure 4-29.—Example of the saturation mixing ratio scale on a Skew T, Log P diagram.

a procedure used by forecasters to study the changes in the atmosphere with time for a single location.

Later, as you progress as an Aerographer's Mate, you will learn more about the other scales on the diagram and their uses.

PRESSURE-ALTITUDE SCALE

A modified procedure to accurately determine heights of features analyzed on a Skew T diagram was introduced in 1987. This procedure requires you to construct a height scale on the diagram before plotting information. You will use the scale to plot reported altitudes of mandatory pressure levels. These levels are then used to construct a pressure-altitude (PA) curve.

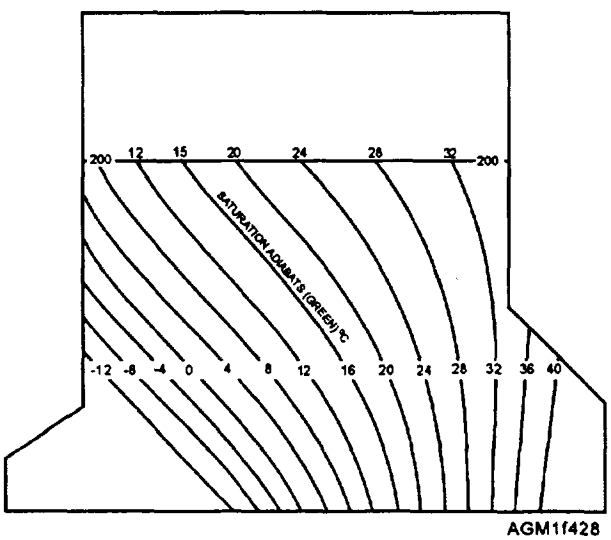


Figure 4-28.—Example of the saturation adiabat scale on a Skew T, Log P diagram.

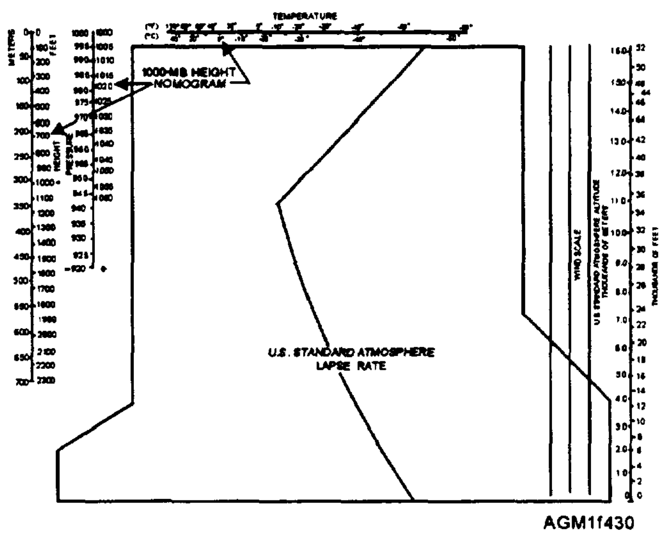
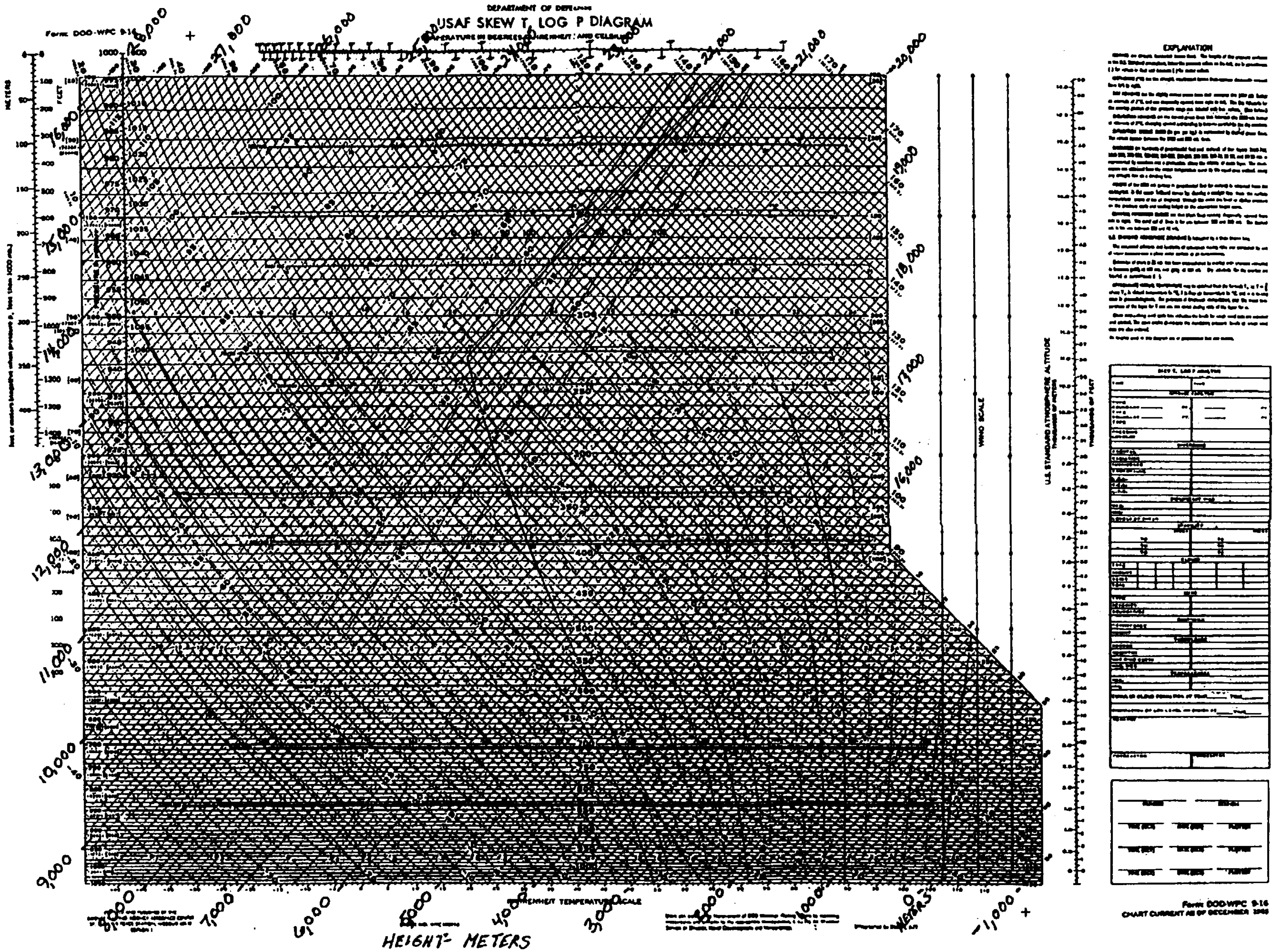


Figure 4-30.—Example of the U.S. standard atmosphere and related height scale, as well as the wind plotting scale.



AGM1f431

Figure 4-31.—Relabeling the Skew T, Log P diagram for the pressure-altitude scale.

TEMP CODE PART A (The indicators for the mandatory pressure levels are bolded) TTAA 64121 72306 **99**030 05050 09015 **00**211 06060 09005 **92**815 02227 08021 **85**490 00646 07016 **70**010 06900 08527 **50**560 22764 09047 40718 33372 09045 30916 459/ / 09071 **25**090 543/ / 09096 **20**225 581/ / 09099 **15**475 595/ / 09615 **10**745 575/ / 09100 88145 589/ / 09098 77132 09628 40508;

SYMBOLIC FORMAT	
$M_iM_iM_jM_j$ YYGGI$_d$ IIiii	(identification)
$99P_0P_0P_0$ $T_0T_0T_{a0}D_0D_0$ $d_0d_0f_0f_0f_0$	(surface)
$P_nP_nh_nh_nh_n$ $T_nT_nT_{an}D_nD_n$ $d_nd_nf_nf_nf_n$	(all other levels)
$88P_tP_tP_t$ $T_tT_tT_{at}D_tD_t$ $d_td_tf_tf_tf_t$ or 88999	(tropopause)
$77P_mP_mP_m$ $d_md_mf_mf_mf_m$ $(4v_bv_bv_av_a)$ or 77999;	(maximum wind)

Figure 4-32.—An example of TEMP coded mandatory level information.

Altitudes reported in upper-air observations are reported in geopotential meters. A geopotential meter is an approximation based on measured temperature, humidity, and pressure values. It is approximately equal to a standard meter.

Drawing the altitude scale requires a slight modification of the diagram. Start by relabeling the 40°C isotherm 0 meters, on the bottom margin of the diagram. Continue labeling the isotherms every 10°C across the bottom margin of the diagram, and then up the left edge of the diagram, in 1,000-meter increments, as shown in figure 4-31. The isotherm scale may now be used also as an isoheight scale, with the -120°C isotherm representing a 16,000-meter isoheight.

To plot information above the 100-hPa level, the altitude scale must be continued. The continuation scale is constructed by labeling the 0°C isotherm on the right margin of the diagram as 16,000 meters, and labeling the isotherms every 10°C in 1,000-meter increments up the right margin, and across the top of the diagram. On this continuation scale, the -120°C isotherm now also represents a 28,000-meter isoheight.

PLOTTING REPORTED INFORMATION

As an observer, you will plot information directly from Parts A, B, C, and D of the TEMP, TEMP MOBIL, and TEMP SHIP coded reports, and from Parts B and D of the PLOT, PILOT MOBIL, and PILOT SHIP coded reports on this diagram.

The usual procedure for plotting information on the diagram is to first plot mandatory pressure-level information (at a pressure level- the altitude, temperature, dew-point depression, wind direction and wind speed), as contained in Parts A and C of the appropriate TEMP, TEMP MOBIL, or TEMP SHIP report. Then, plot the significant level information (at a pressure level- the temperature and dew-point depression) reported in Parts B and D of the appropriate TEMP, TEMP MOBIL, or TEMP SHIP report. Next, the significant level winds (at a pressure level- wind direction and wind speed) from Parts B and D of the TEMP, TEMP MOBIL, or TEMP SHIP code when used outside of WMO Region IV. The fixed regional level winds from Parts B and D of the PILOT, PILOT MOBIL, or PILOT SHIP coded reports, as used within WMO Region IV, are plotted instead of significant level winds.

Use of Plotting Colors

Colors are used only to indicate the age of the trace. Black ink is normally used for history-a tracing of an older sounding onto a new diagram that is to be used to plot new information. The first plotted sounding on a diagram is normally done in blue ink or pencil. A second sounding plotted on the diagram is done in red ink or pencil. All data plotted for each sounding is plotted in the same color. If only one set of data is plotted on a diagram, blue ink or pencil is used to plot altitudes, temperature, dew-point depressions, and winds. The same color is used to enter information in the Legend block and, by the analyst, in the Analysis block. The analyst may use different colors, as desired, during analysis of information on the diagram.

Plotting Mandatory Levels

From Part A of the upper air coded message, locate the information for the surface and each mandatory pressure level to 100 hectopascals (fig. 4-32).

The reported altitude of the surface and each mandatory level is written on the right side of the colored portion of the diagram immediately above the printed isobar value (fig. 4-33). Notice that the 925-hPa mandatory level is not printed on the diagram. Mark the 925-hPa level with a tic mark on the edge of the diagram and enter the reported altitude just above this level, as shown in the figure. The three digits encoded for the altitude are converted to actual altitude values by the observer, following the guidance given in table 4-2.

When the reported surface pressure is less than 1,000 hPa, such as 976 hPa, an extrapolated 1,000-hPa height below station level is reported following the 00 indicator for the 1,000-hPa level. (In this case the 1,000-hPa level temperature/dew-point depression group and the winds group would be encoded as slashes.) For example, a reported level 00531 ///// ///// indicates a 1,000-hPa height as -03 1 meters (the 5 indicates a negative value), while a reported height of 00631 would indicate -13 1 meters. The height of the surface level is assumed to be zero.

The height is then plotted as a small dot surrounded by a *2/8*- to 3/8-inch square, at the intersection of the isobar of the mandatory pressure level and the isoheight line of the constructed height scale (fig. 4-34). Each printed isotherm is 100 meters. Estimate placement of the dot to the nearest 10 meters.

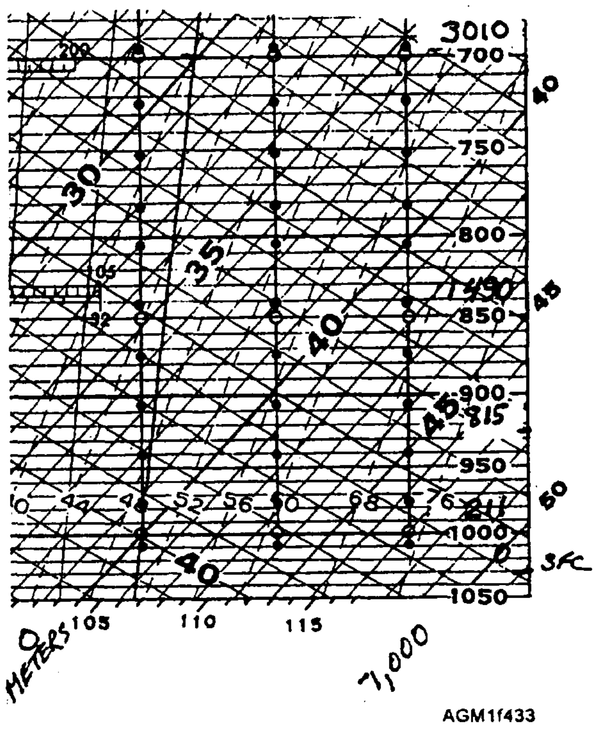


Figure 4-33.—Plotted altitude values.

On the same horizontal isobar, the temperature is plotted as a small point surrounded by a 2/8- to 3/8-inch-diameter circle where the isotherm crosses the isobar. Temperatures are plotted to the nearest tenth degree Celsius (fig. 4-35). Estimate the position between the printed isotherms. Remember, if the reported tenths value is even, the temperature is above zero, and if the tenths value is odd, the temperature is below zero degrees Celsius.

To plot the dew-point depression, move along the isobar toward the left the number of degrees and tenths of degrees indicated by the encoded dew-point depression. Place a small point at the indicated value and surround the point with a 2/8- to 3/8-inch-high triangle (fig. 4-36). Remember, dew-point depression is the difference between the dew-point temperature and the temperature, and the dew-point temperature is either the same as or lower than the temperature. Also, remember that dew-point depression values are in degrees and tenths of a degree Celsius for code figures 00 to 50, while reported values 56 to 99 are in whole degrees when 50 is subtracted from the code figure. For example, the code figure 43 is a dew-point depression of 4.3°C, while 63 is (63 - 50 = 13) a dew-point depression of 13.0°C.

The next encoded value, wind direction, is plotted on the right wind scale for the first sounding plotted on a diagram, and succeeding reports are plotted on the

Table 4-2.—Rules for Converting Encoded Altitude to Actual Altitude

LEVEL (hPa)	RULE
1000 925	no change
850	prefix with a *1*
700	prefix with a *2* if ≥500, or a *3* if <500
500 400 300	Suffix with a *0*
250 200 150 100 70	prefix with a *1* and suffix with a *0*
50 30 20	prefix with a *2* and suffix with a *0*

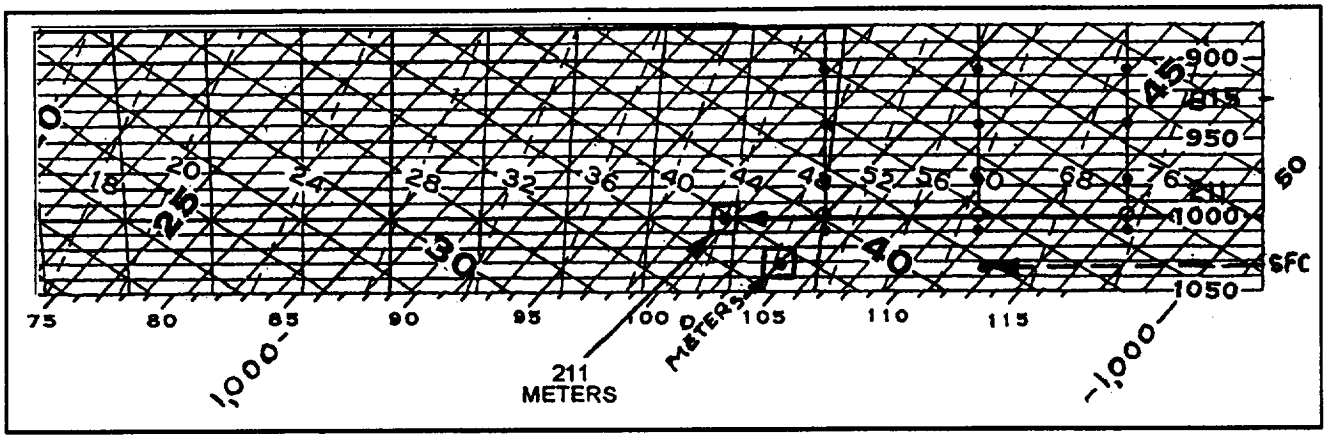


Figure 4-34.—Plotting reported altitude of the surface and mandatory-pressure level.

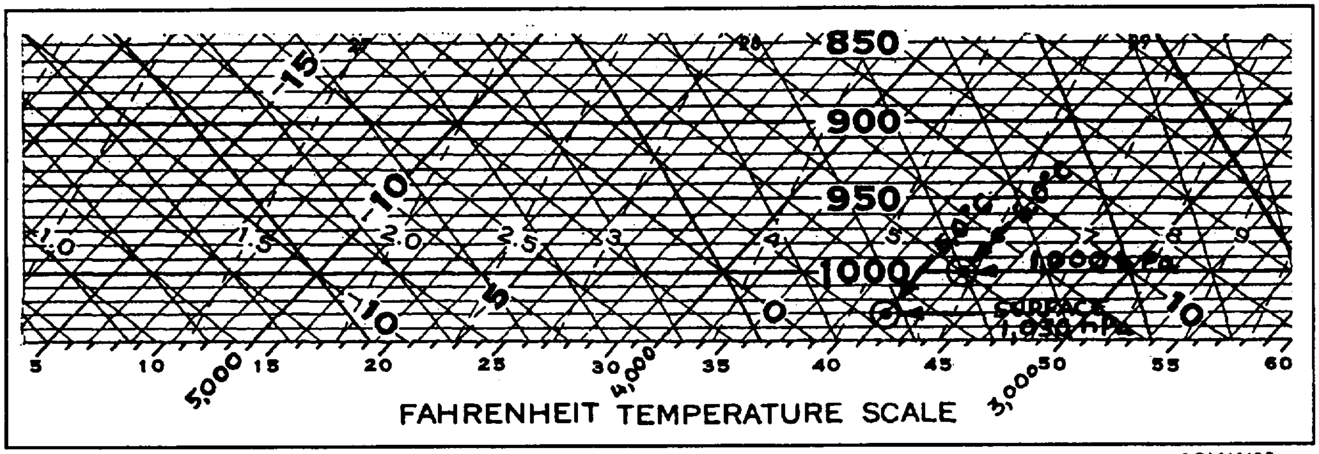


Figure 4-35.—Temperature plotted on the mandatory pressure level isobar at the intersection of the isotherm value.

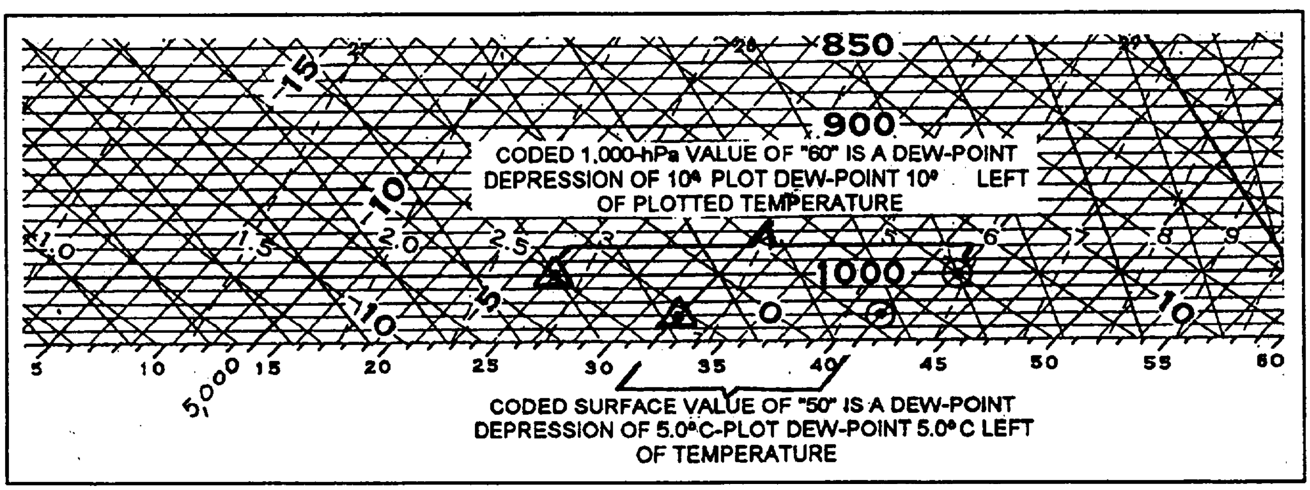


Figure 4-36.—Dew-point depression plotted to left of temperature at each mandatory pressure level.

center and/or left wind scales. The right-most wind scale is used to transfer wind history from a previously plotted diagram. The wind shaft is drawn extending from the small, nondarkened circle at each mandatory level isobar in the same manner that a constant-pressure level wind is plotted. For plotting wind direction, true north is the top of the chart, and due south, the bottom of the chart. The shaft extends toward the reported wind direction, the tens value of the wind direction is written near the end of the shaft, and the odd five-degree increments of reported direction are indicated by a small plus sign (+) after the tens value of the direction.

Wind speed is indicated on the wind shaft in the same manner as surface and constant-pressure level plots (fig. 4-37).

The data for the mandatory pressure levels above 100 hectopascals is obtained from message Part C, and plotted in the same manner. Levels of missing data are noted on the diagram just above the last available reported data.

After the mandatory level data is plotted, the pressure altitude curve may be drawn. This is discussed following this section on plotting data, but must be accomplished before fixed regional level winds are plotted.

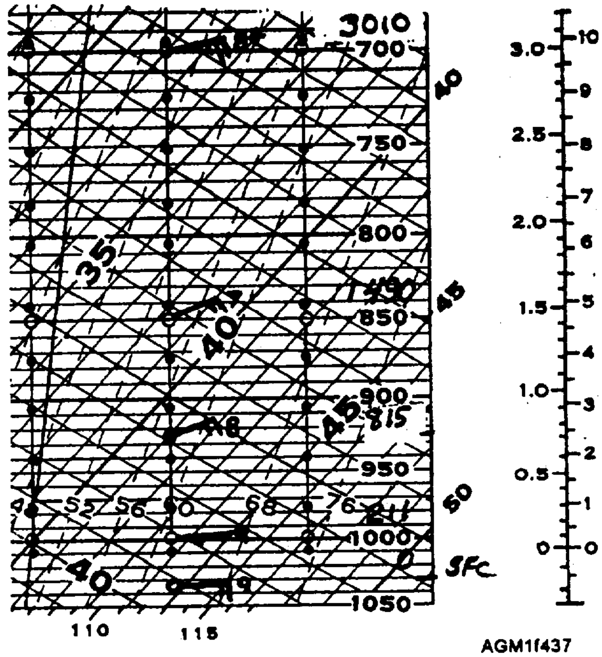


Figure 4-37.—Wind direction and speed plotted at each mandatory pressure level.

Plotting Significant Levels

All significant level data is normally plotted in addition to the mandatory level data. All stations report

TEMP CODE PART B (NON-REGION IV)—Significant level indicators for both temperature/humidity and winds are bolded.

TTBB 64120 47580 **00**030 05050 **11**930 06040 **22**770 02920 **33**650 10100 **44**600 14740 **55**435 29769 **66**358 38170 21212 **00**030 13015 **11**990 17022 **22**985 17035 **33**972 17015 **44**925 18005 **55**860 19015 **66**700 20025 **77**550 22040 **88**320 23050 **99**300 23070 **11**260 23112 **22**220 23090 **33**100 24060 31313 46105 81135 41414 43322;

SYMBOLIC FORMAT—

$M_iM_iM_jM_j$ $YYGGa_4$ IIiii	(identification)
$n_nn_nP_nP_nP_n$ $T_nT_nT_{an}D_nD_n$	(significant temperature and humidity levels)
21212 $n_nn_nP_nP_nP_n$ $d_nd_nf_nf_nf_n$	(significant wind levels - not included in Region IV)
31313 $s_rr_ar_as_as_a$ 8GGgg $(9s_sT_WT_WT_W)$	(sounding system and tracking method, observation time and SST)
41414 $N_hC_LhC_MC_H$;	(cloud data)

Figure 4-38.—Significant temperature/humidity and wind levels as reported in TEMP code.

significant temperature and humidity levels in Part B and D of the TEMP, TEMP MOBIL, or TEMP SHIP coded message.

Ships and land stations outside of Region IV report significant level winds in Parts B and D of the TEMP message following the 21212 indicator group (fig. 4-38). Within WMO Region IV, significant level winds are not reported. However, fixed regional level winds are reported in Parts B and D of the PILOT, PILOT MOBIL, or PILOT SHIP code (fig. 4-39).

The first significant level is the surface, repeating information previously reported in Part A. All remaining significant levels should be plotted. Plot the temperature, dew-point depression, and winds at the isobar level reported. You may have to estimate between isobars and between isotherms drawn on the diagram to locate the correct placement of the reported information. Plot temperatures, dew-point depressions, and significant level winds the same way as for the mandatory levels.

Plotting Fixed Regional Level Winds

The fixed regional level winds (FRLW) are plotted on the wind scale on the blackened circles. The altitude scale (kilometers and thousands of feet) located just to the right of the wind scales is used to identify the preplotted FRLW circles on the wind scale. Remember, although the indicated altitude increments in the coded fixed regional level winds may be thought of as thousands of feet, the value indicated is actually the number of 300-meter increments above the surface. For example, 90012 indicates three FRLWs follow, the first at a "00" 300-meter increment altitude (surface), the second at a "01" 300-meter increment altitude (0.3 km), and the third at a "02" 300-meter increment altitude (600 meters or 0.6 km). Alternatively, you may think of the wind reports as the surface, 1,000-foot, and 2,000-foot levels. Plot the reported wind at the blackened

TEMP CODE PART B (WMO REGION IV)

TTBB64120 72306 **00**030 05050 **11**930 06040 **22**770 02920 **33**650 10100 **44**600 14740 **55**435 29769 **66**358 38170 31313 46105 81135 41414 43322 51515 10153;

SYMBOLIC FORMAT

$M_iM_iM_jM_j$ YYGGa$_4$ IIiii	(identification)
$n_nn_nP_nP_nP_n$ $T_nT_nT_{an}D_nD_n$	(significant temperature and humidity levels)
31313 $s_rr_ar_as_as_a$ 8GGgg ($9s_ST_wT_{ww}$)	(sounding system and tracking method, observation time and SST)
41414 $N_hC_LhC_MC_H$	(cloud data,
51515 101. . . . . . . ;	(additional data groups)

PILOT CODE PART B (FIXED REGIONAL LEVELS-REGION IV)

PPBB 64121 72306 90012 10013 09523 10020 90346 11510 12005 12505 90789 14005 15508 16510 91246 17015 18019 18523 9205/ 20025 21530;

SYMBOLIC FORMAT

$M_iM_iM_jM_j$ YYGGa$_4$ IIiii	(identification)
$9t_nu_1u_2u_3$ dddff dddff dddff . . . . . ;	(significant wind levels)

Figure 4-39.—Significant temperature/humidity levels in TEMP code, with fixed regional level winds reported in PILOT code.

circle horizontally even with the indicated value on the altitude scale (fig. 4-40).

When there is a significant difference between your station's elevation and sea level, or if the surface pressure is greatly different than 1,013 hPa (standard pressure), then the preplotted dots for the fixed regional level winds will not be accurately spaced with respect to the mandatory level wind plots. In these cases, the forecaster may desire that you plot the fixed-regional level winds by establishing the altitude using the pressure-altitude curve, as shown in figure 4-40.

Plotting Tropopause Height

The tropopause information is encoded in Part A or C of the TEMP coded messages following the mandatory level information. The three groups of information start with the indicator 88. The format of the data is shown in figure 4-32. The reported tropopause information (pressure level, temperature, dew-point depression, and wind direction and speed) is plotted just as a mandatory level. Additionally, in the uncolored portion of the diagram between the left wind scale and the diagram, a horizontal line is extended from the tropopause pressure level, and the block letters *TROP* are written above the line. When group 88999 is reported, the block letters *NO TROP* are written just to the right of the colored portion of the diagram at the 100-hPa level. See figure 4-41 for examples of both plotted tropopause and maximum wind information.

Plotting Maximum Wind

The maximum wind pressure level, wind direction and speed follows the 77 indicator or the 66 indicator in Part A or C of the message. At the pressure level reported, a dashed horizontal line is drawn extending from the right side of the colored portion of the diagram and the word *MAX* is written on the line. The maximum wind is plotted at that same level on the wind scale. Wind shear values, if reported, are usually not plotted.

Plotting Supplemental Information

Much of the additional data following the 51515 group in Parts B and D of the TEMP code can be plotted on the diagram. If the group refers to a single level, a straight line is usually drawn at the pressure level, and the remark entered on the diagram. If the code refers to a layer of the atmosphere, the top and bottom of the layer are indicated by drawing horizontal lines at the pressure level, and the comment is entered on the chart. These coded remarks may refer to the reason for termination, levels of doubtful or missing data, or

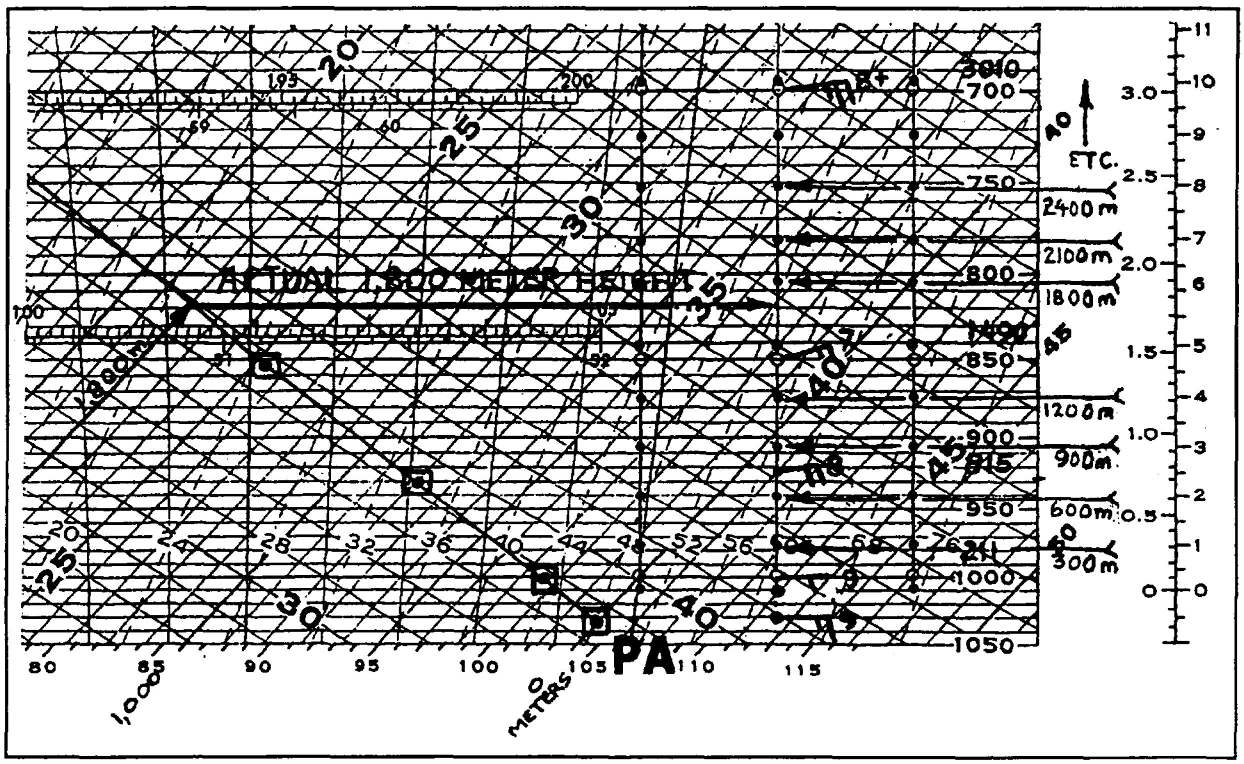


Figure 4-40.—Fixed regional level winds may be plotted on the solid dots on the wind scale, or positioned using the PA curve.

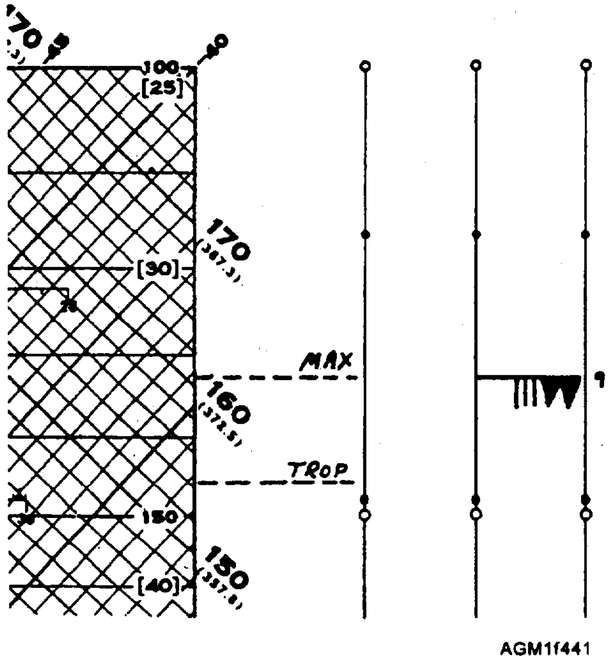


Figure 4-41.—Plotted tropopause and maximum wind information.

freezing levels. The 10190 group reports extrapolated altitude of the next higher standard pressure level after sounding termination. The altitude may be entered and plotted on the diagram, and *EXTRAP* should be written after the altitude to indicate it is extrapolated data. Sea-surface temperature, as reported following the 31313 group, may be plotted directly under the temperature trace in the bottom margin of the diagram. An SST of 15.7°C would be plotted as SST = 15.7°C.

TEMPERATURE TRACE

The temperature trace is constructed by connecting each of the plotted mandatory- and significant-level temperature plots with a thin solid line. Use a straight-edge as a guide to draw the lines between each plotted temperature, in order, from the bottom of the diagram to the top. Label the temperature trace with a block letter *T* at both the top and the bottom.

DEW-POINT TRACE

The plotted position of the reported dew-point depressions represents dew-point temperature. The dew-point temperature trace is constructed by connecting each of the mandatory- and significant level dew-point plots with a thin dashed line, in order, from the bottom of the diagram to the top. The trace is labeled with the letters *Td* at both the top and bottom.

PRESSURE-ALTITUDE (PA) CURVE

The pressure-altitude (PA) curve is constructed by connecting each of the plotted height points with a continuous solid line. When levels above the 100-hPa level are plotted on the diagram, a separate continuation PA curve is constructed connecting the consecutive altitude plots for the levels above 100 hPa. Each of the pressure altitude curves should be nearly a straight line, curving slightly upwards. A sharp bend in the curve at a particular height usually indicates either a misplotted height or a reporting error. The PA curve is labeled at both the top and bottom with the block letters *PA*.

As a Navy or Marine Corps observer, you will continue working on your requirements for advancement, and begin to analyze features on the Skew T, Log P diagram. Whether you are analyzing a manually plotted Skew T diagram or using computer assistance to analyze a Skew T displayed on a video terminal, a through understanding of the plotting methods presented in this section is essential. Information on analysis techniques on the Skew T, Log P diagram is presented in NAVAIR50-1P-5, *The Use of the Skew T, Log P Diagram in Analysis and Forecasting.*

REVIEW QUESTIONS

Q43. What do the slightly curved, solid brown, left-diagonal lines on the Skew T diagram indicate?

Q44. What do the saturation mixing ratio lines indicate on a Skew T diagram?

Q45. How are heights of features accurately determined from a Skew T diagram?

Q46. What would be the height of a 1000-hPa level reported in Part A as 00526?

Q47. When pressure heights are being plotted on a Skew T diagram, each printed isotherm is equal to how many meters?

Q48. What symbol is used to indicate dew-point depression on the Skew T diagram?

Q49. What part(s) of an upper air TEMP coded report contain signifcant level data?

Q50. In what manner is the level of maximum wind annotated on a Skew T diagram?

```
UNCLAS/ /N03123/ /
PPP MOVREP CONSTELLATION, AVWX 01/ /
ORG SP CONSTELLATION, 02/ /
ETD P SAN DIEGO CA, 191400Z5 FEB 03/ /
VIA L 32-40N9 118-11W2, 191756Z9 FEB 04/ /
VIA L 33-00N6 119-58W4, 200115Z9 FEB 05/ /
MOD LOC 32030N8 118-50W5 200516Z4 FEB OPERATING WITHIN 100NM, 06/ /
ORG SP DOWNES, 07/ /
RDV L 32-40N9 118-11W2, 191856Z0 FEB 08/ /END
```

Figure 4-42.—Typical movement report (MOVREP).

SHIP'S MOVEMENT REPORT (MOVREP) AND POINTS-OF-INTENDED MOVEMENT REPORT (PIM)

LEARNING OBJECTIVES: Discuss and define the terms used in the ship's movement report (MOVREP) messages and the points-of-intended-movement (PIM) reports. Explain how PIM are plotted on a chart or display.

Navy and Coast Guard ships usually send a Movement Report (MOVREP) message before leaving a port or an operating area. Understanding MOVREPs is not difficult if the format, terms, and standard abbreviations are known.

MOVEMENT REPORT

The MOVREP message uses a specific format and abbreviated plain language (fig. 4-42). Each line is numbered at the end of text, such as 01//, or 08//. This will enable the reader to know if any lines of information have been lost or deleted.

A MOVREP will always have END at the end of the last line to alert the reader that no additional lines follow. Check-sums, a method of verifying that no numbers in a group were deleted or changed during transmission, are used with all date-time groups and latitude or longitude positions. To obtain a check-sum, add all of the digits in a reported group together, and the units digit of the resulting sum is the check-sum.

MOVREP TERMS AND STANDARD ABBREVIATIONS

Line 1 identifies the sender of the report and contains requests for Enroute Weather Forecasts (WEAX), Aviation Enroute Weather Forecasts (AVWX), or other specialized geophysics support. Line 2, ORG, provides the ship (SP), which will change position. The ETD line provides the estimated time of departure and location (*P* for port, *L* for latitude/longitude, or *POS* for present position), and UTC departure date-time group. The date-time groups are always arranged in the format ddhhmmZk MMM, where dd is the day of the month, hh is the UTC hour, mm is the UTC minute, and MMM is the three-letter month abbreviation. The k is a check-sum. Enroute latitude and longitude positions and times follow the term *VIA.* Latitude and longitude points are provided in degrees and minutes, with check-sums. Occasionally, the type of route will be identified by GC for great circle, RB for rhumb line, DI for direct route, CO for coastal route, or STM for storm evasion. The destination follows either an ETA or MOD designation. ETA stands for estimated time of arrival, and is normally followed by a port or position and a date-time group. MOD stands for miscellaneous operational details, and is most commonly seen followed by the term *LOC,* for local operations. The last two lines in the example indicate that CONSTELLATION will rendezvous (RDV) with the DOWNS, at the position and time indicated.

POINTS OF INTENDED MOVEMENT

Aboard ship and ashore, Aerographers frequently must keep track of their own and other ships movements and locations. This is done by plotting a ship's Points of

Intended Movement (PIM) on either a paper chart or in a computer video display. These positions are used by the forecaster to determine where the ship will be at any given time, so the weather may be properly forecasted.

Your own ship's PIM may be obtained from the Quartermaster-of-the-Watch (QMOW), or the navigator at a navigation briefing. The PIM may be in the form of a series of latitude/longitude points, with UTC times, or may be stated simply as, "making course 123 true, SOA 12 knots."

PIM TERMS AND DEFINITIONS

"Making course" means the ship is actually traveling in that direction. This is different from heading or steering course, which, due to the effects of winds, seas, and currents, may be different from the direction the ship is actually moving.

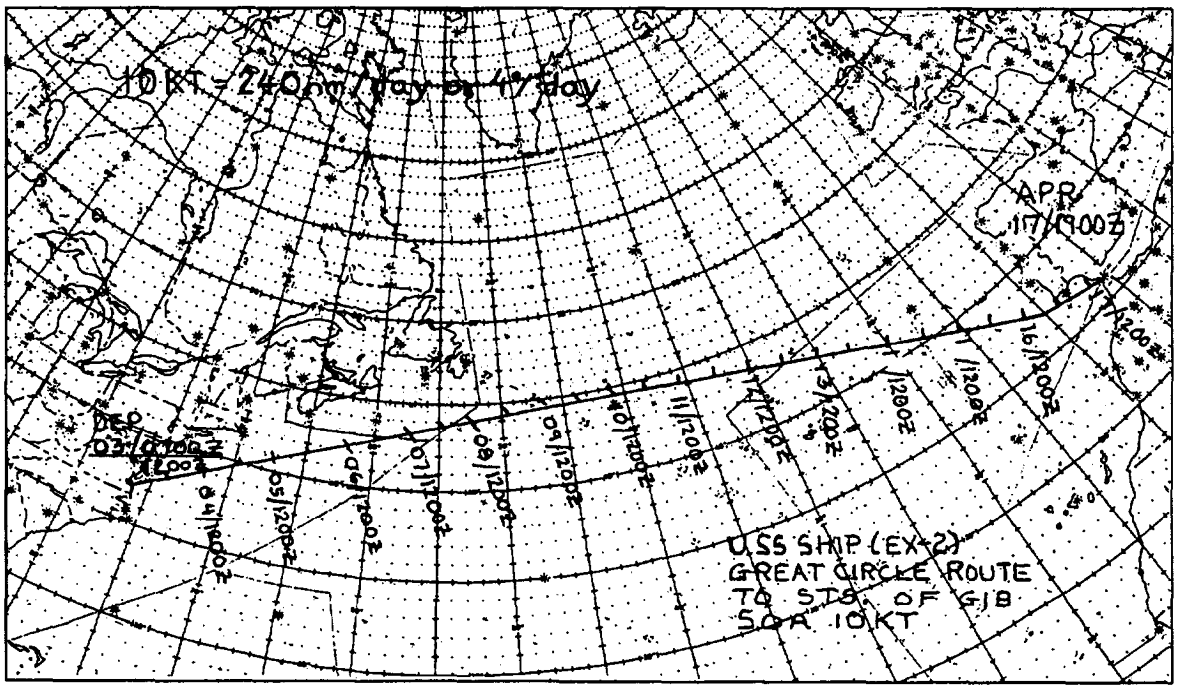
The term SOA means speed of advance, and has the same meaning as speed made good—it is the speed the ship is actually moving. This is not the same as indicated speed—the speed the ship can make without considering winds, seas, and currents, based on the engine RPMs.

PLOTTING PIMs

When plotting PIMs, use a great circle chart or a polar-stereographic background to plot great circle routes. Plot all other routes on a Mercator chart or display background.

Plot PIMs either on a paper chart or the computer display by placing a dot or anx at the reported positions and writing the UTC date-time group next to that position. Indicate MOD LOC positions by drawing a circle of the diameter reported, around the latitude and longitude reported. For direct routes, connect the reported positions with straight lines; for coastal routes, connect the positions with lines running parallel to the coast. Connect reported rhumb-line route positions and great-circle route positions (on a polar stereographic chart) with straight lines. Mark the chart or display with the name of the ship or the task force/task group name, and the message date-time group of the MOVREP.

You will usually be rquired to indicate intermediate times along the ship's track, such as 12-hour increments at 0000Z and 1200Z daily. To do this, measure the length of the ship's track or a segment of the track with a set of dividers. Convert the length of the track to distance in degrees by comparing it to the latitude scale on the chart. Divide the distance, in degrees, by the length of time, in hours, indicated for the track or segment to obtain anticipated movement in degrees latitude per hour. Then, multiply by the number of hours in the desired increment to find the length of each individual segment. Use the divider to transcribe these segment lengths along the PIM track, and mark a short line across the track at each intermediate distance. Beside each mark indicate the date and time (fig. 4-43).



AGM1f443

Figure 4-43.—Intermediate times marked on a ship's PIM chart.

REVIEW QUESTIONS

Q.51. On what line of a movement report might you findrequestsfor an en route weather forecast?

Q.52. What does the term MOD-LOC indicate on a movement report?

Q53. What does the term SOA actually mean?

Q54. How are intermediate positions determined on a PIM chart?

SUMMARY

Many different types of graphic products are routinely produced for briefing purposes. In this chapter, we have discussed the terms used to describe various meteorological parameters on these products, the standards for the display of these parameters on graphic products, as well as the types of charts used to display graphic products. We covered in detail the plotting of both surface and upper-air observation reports, and the plotting of the Skew T, Log P diagram. In addition, we discussed the parameters of the movement report (MOVREP) and the plotting of points of intended movement (PIM) data.

ANSWERS TO REVIEW QUESTIONS

A1. The geographical coordinate system and the grid coordinate system.

A2.. 1°

A3. 23.9N and 120.6W.

A4. The particular grid zone is identified by the column number and the row letter,

A5. 24N and 32N latitude and 18W and 24W longitude.

A6. A 10 meter grid zone.

A7. Near the poles.

A8. The geographic definition of the tropics is the area of the earth lying between the Tropic of Cancer at 23 1/2°N and the Tropic of Capricorn at 23 1/2°S

A9. This is due to the curvature of the earth. Lines of longitude converge near the poles, and as Great Circle routes arc toward the poles, there is less distance between lines of longitude and thus a shorter distance to travel.

A10. 1:10,000 since the smaller the scale the greater the detail.

A11. The National Imagery and Mapping Agency (NIMA).

A12. The National Imagery and Mapping Agency (NIMA) Catalog of Maps, Charts, and Related Products.

A13. A WMO blocck/station number ending in zero indicates a designated synoptic observation reporting station.

A14. The Master Weather Station Catalog.

A15. The letter "K".

A16. FAA Order 7350.6 Location Identifiers.

A17. A forecast normally covers a shorter period of time (less than 72 hrs) while an outlook is typically for 3 to 10 days in the future and implies a lower level of confidence.

A18. A briefing aid is any product designed primarily to be used in a briefing to assist the explanation of the current and forecast positions.

A19. Yellow.

A20. (a) Occluded front: purple.

(b) Instability/squall line: blue.

A21. Blue.

A22. (a) Clear air turbulence (CAT): blue.

(b) Nonconvective continuous frozen precip: red.

A23. 4 hPa.

A24. 120 meters.

A25. 3 feet.

A26. Isodrosotherms

A27. Isallobars.

A28. TESS data can be manipulated to plot only one type of chart, such as a temperature analysis, pressure analysis, vice using a single chart to analyze all information,

A29. Wind direction is missing.

A30. Upper left of the station circle.

A31. Just to the right of the station circle.

A32. At the bottom of the station plot.

A33. By filling in the station circle with the applicable symbol.

A34. By using a small arrow to indicate direction. The speed isplotted in whole knots.

A35. The dew-point depression is less than or equal to 5°C.

A36. Below and to the right of the plot.

A37. Intermittent rain (not freezing), heavy at the time of observation.

A38. Lightning visible, no thunder heard.

A39. Snow (not falling as showers) during the past hour, but not at the time of observation.

A40. Every 2 degrees Celsius.

A41. With an X.

A42. A straight arrow is drawn for sea waves and a wavy arrow is drawn for swell waves. A smaller wavy arrow may be drawn for secondary swells. The direction of the arrow is the direction the waves are MOVING TOWARD.

A43. Dry adiabats.

A44. The greatest amount of water vapor that may be contained in a parcel of air expressed in units of grams of water vapor per kilogram of dry air.

A45. By the use of a properly constructed pressure-altitude (PA) curve.

A46. -26 meters.

A47. 100 meters.

A48. A triangle is used to indicate dew-point depression values.

A49. Parts B and D.

A50. At the pressure level reported, a dashed horizontal line is drawn extending from the right side of the colored portion of the diagram. The pressure level and the word "Mm are written on the line.

A51. Line 1.

A52. Miscellaneous operational details/local operations.

A.53. Speed-of-advance. It is the speed the ship is actually moving or the speed made good.

A54. Divide the distance (in degrees) by the length of time (in hours) indicated to obtain anticipated movement in degrees latitude per hour. Multiply by the number of hours in the desired increment to find the length of each individual segment.